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13

Technical Report LWL-CR-01F71

DEVELOPMENT OF A FLOATING SMOKE GRENADE

AIR AND SURFACE TO SURFACE

FINAL REPORT

UNDER CONTRACT NO.
DAAD05-71-C-0154

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ABSTRACT

The objective of this program was to design and demonstrate the feasibility of a floating smoke grenade which could be ground or air launched. The floating smoke grenade would supplement or replace the currently operational M8 and M18 smoke grenades which do not float and, therefore, provide poor signals when thrown in water. Furthermore, when air launched, the M8 and M18 tend to bury themselves in mud and shallow water due to their high terminal velocity at impact. To overcome this problem, the floating smoke grenade also required an aerodynamic decelator. A smoke inflated "ballute" provided this element.

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FOREWORD

This report was prepared for the Land Warfare Laboratory, Aberdeen Proving Ground, Maryland by Northrop Carolina, A Subsidiary of Northrop Corporation. This report presents the results of the program conducted under Contract DAAHD05-71-C-0154 during the period of November 1970 through June 1971. This effort was conducted to fulfill the Small Development Requirement for Grenade, Hand/Rifle, Smoke (Floating) USACDC 14479.

Contributors to the work reported herein and not listed as authors are:

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SUMMARY

The objective of this program was to design and demonstrate the feasibility of a floating smoke grenade which could be ground or air launched. The floating smoke grenade would supplement or replace the currently operational M8 and M18 smoke grenades which do not float and, therefore, provide poor signals when thrown in water. Furthermore, when air launched, the M8 and M18 tend to bury themselves in mud and shallow water due to their high terminal velocity at impact. To overcome this problem, the floating smoke grenade also required an aerodynamic decelerator.

The "ballute" technology developed for the TMF-1 40 mm Floating Target Marker was applied successfully to the design of the Floating Smoke Grenade, and all program objectives were met. The smoke inflated ballute acts both as a flotation collar and a "parachute."

A total of 332 units were fabricated and tested during the program. These include development tests, feasibility demonstration tests, environmental tests, and acceptance testing of delivered units. Units were hand launched and air dropped over water during the test program. Signal visibility tests were conducted by observing the functioning units from an aircraft. In all cases, color identification and signal acquisition distances exceeded the required minimum of 3000 meters at an altitude of 1000 feet.

In all, five colors of smoke were developed including red, yellow, green, white, and violet. In controlled comparison tests, these smoke colors were found to be equal to or better than the M8 and M18 colors. Smoke volume was slightly less than the M8 and M18, but burn time was almost twice as great as that of the M18 and equal to that of the M8.

In the bullet impact tests, the green, red and violet compositions did not ignite. White and yellow grenades ignited and burned non-violently. There were no detonations. Dry grass ignition tests were also conducted. Straw which had been dried in an oven for 30 days at 160°F was used in these tests. Violet and yellow grenades which were completely covered with straw started fires after 90 seconds. Green, red, and white units did not start fires.

At the completion of the program, 320 grenades (65 of each color) were fabricated and delivered to the Government for further evaluation.

TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>	<u>Page</u>
I	INTRODUCTION	1
II	HARDWARE DESIGN	5
III	SMOKE COMPOSITIONS	8
	1. General	8
	2. Ignition Starter Mixture	9
	3. Inflation Mix	9
	4. Smoke Composition	9
IV	TEST RESULTS	12
	1. Development Tests	12
	2. Feasibility Demonstration Tests	14
	3. Environmental Tests	15
	4. Delivery Acceptance Tests	16
V	CONCLUSIONS AND RECOMMENDATIONS	17
APPENDIXES		
	A. Data for Color Comparison Units	18
	B. Green Smoke Data	20
	C. Red Smoke Unit Data	27
	D. Violet Smoke Unit Data	39
	E. White Smoke Unit Data	46
	F. Yellow Smoke Unit Data	52
	G. Summary of Smoke Composition and Charge Configuration of the Floating Grenade Units	56
	H. Environmental Test Data for Feasibility Demonstration Units	58
	I. Function Test Data for Delivery Acceptance Units	63
	J. Environmental Testing of Floating Smoke Grenades	79

SECTION I

INTRODUCTION

The objective of this program was to design and demonstrate the feasibility of a floating smoke grenade which could be ground or air launched. This grenade will broaden the Army's smoke capability to include screening, screening, and signaling in areas that are partially or completely covered with water. Experience in Vietnam has shown that the standard smoke grenades (AN-M8 and M18) are ineffective in such areas.

The primary technical requirements for the floating smoke grenade as specified in the Statement of Work No. DAAD05-71-Q-0410 is summarized in Table I. The greatest emphasis was placed on reliability which dictated a minimum of new, unproven concepts and/or components. The body, bottom, top and fuze for the floating grenade are the same basic components used on the M18 Smoke Grenade. The chimney and ballute assembly was developed on the TMF-1 Smoke Marker, a 40 mm smoke streamer program, and a floating rescue marker program. The smoke composition is the same basic formulation developed for the TMF-1 Marker.

The design of the floating smoke grenade is shown in Figure 1. Figure 2 illustrates the operation of the floating smoke grenade. The grenade may be hand thrown, rifle launched, or aircraft launched from any dispenser compatible with the M-18. Approximately two seconds after the firing arm is released, the output of the fuze delay ignites the smoke mix first fire. The resultant pressure generated inside the canister fails the taped joint on the can, thereby separating the top section of the canister from the main body of the grenade. A cord attached between the top and main body prevents the former from becoming a missile hazard. Gases from the smoke mix inflate the ballute instantaneously. The inflated ballute, acting as an aerodynamic decelerator, slows the descent rate of the grenade to approximately 40 feet per second. At this descent rate and with its large frontal area (approximately 80 square inches), the smoke grenade will impact so gently in shallow water that it will not bury itself in soft mud below the surface. The design of the floating smoke grenade, the smoke compositions, and overall performance parameters are described in detail in Section II.

TABLE I - FLOATING SMOKE GRENADE REQUIREMENTS

Item	Requirement	
	Essential	Desired
Number of major components	One	---
Weight	---	12 oz to 32 oz
Envelope	Same as ANM-8 and ANM-18	---
Environment	Wet-hot, AR70-38	All climatic conditions
Paradrop	Yes	---
Assembly/disassembly time	None	---
Power requirements	None	---
Transportability	Man-air transportable	---
Observation distance	3000 meters from 1000 ft min. altitude	---
Expendable	Yes	---
Impact insensitive to small arms fire	Yes	---
All weather operation	Yes	---
Visible time	1.5 minutes	3 minutes
Reliability in inundated areas	95%	---
Grass fire hazard	None	---
Smoke volume	Same as ANM-8 and ANM-18	---
Colors	Red, yellow, violet, green and white	---
Storage life	5 years	---
Maintenance	Visual	---
Human engineering	No special training, safe to operate; AR602-1 and AR385-16	---
Priority of characteristics	Reliability, performance	---

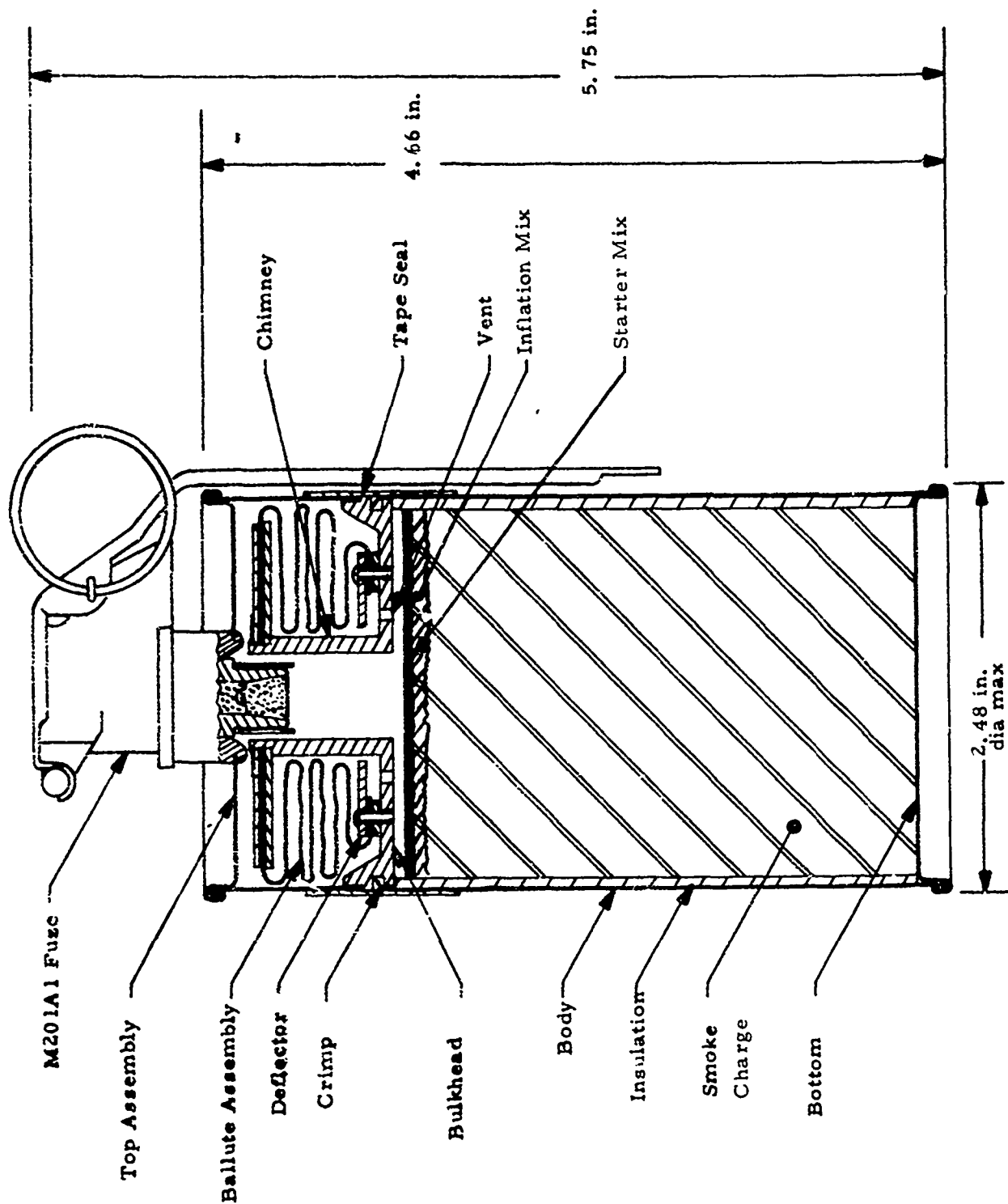
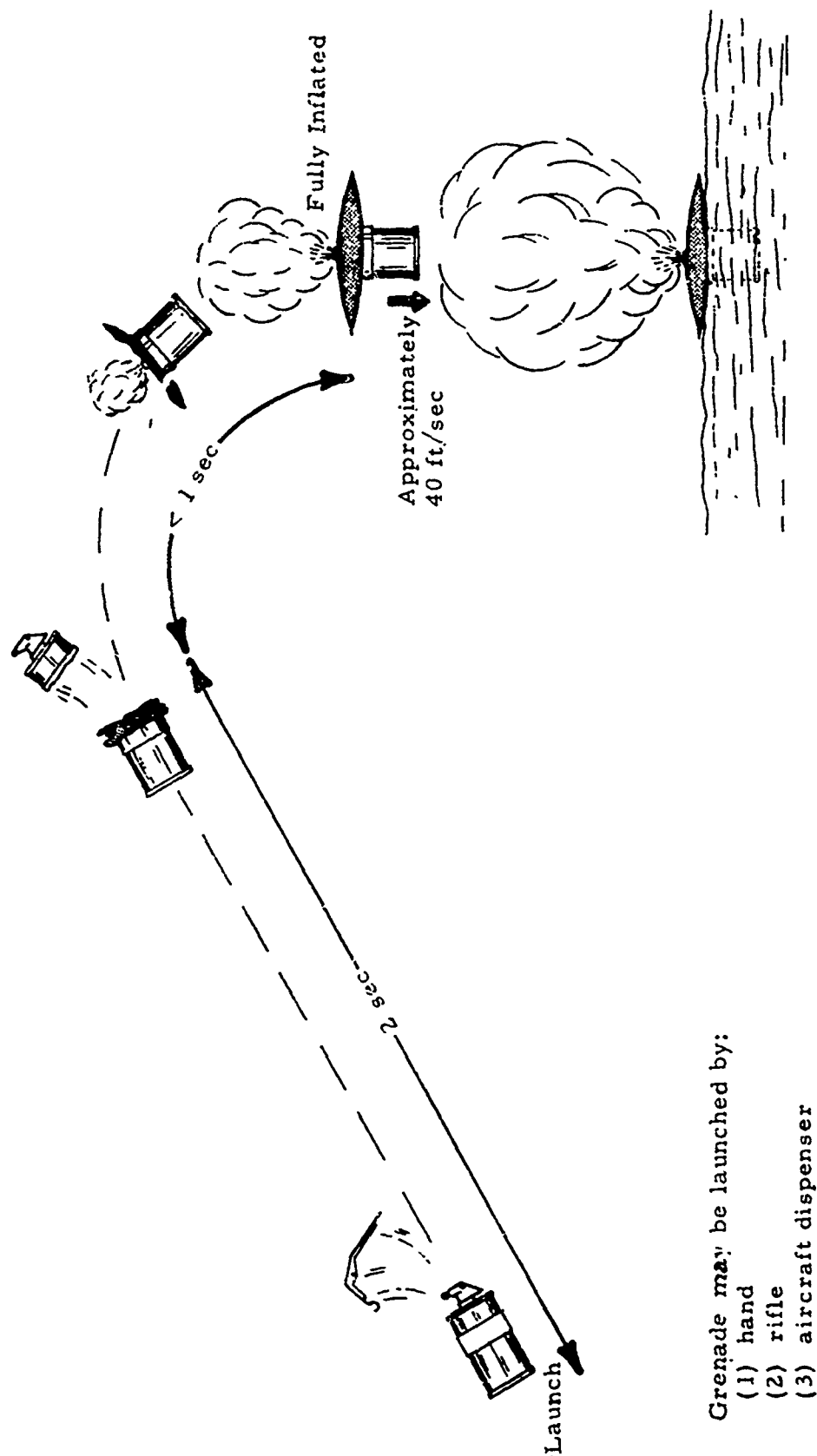


Figure 1 - Floating Smoke Grenade



Grenade may be launched by:

- (1) hand
- (2) rifle
- (3) aircraft dispenser

Figure 2 - Floating Smoke Grenade Sequence of Operation

SECTION II

HARDWARE DESIGN

1. BODY

The body is made from the M-18 body, drawing number C13-19-82-1. The basic material is terneplate which is rolled into a cylinder and joined by a longitudinal soldered seam. The body is made in two parts, which are subsequently joined to the chimney during the final assembly operation.

The canister body was altered for the delivery units to provide more material for crimping the canister bottom to the ballute assembly. The body was lengthened .37 inches.

2. BOTTOM

The bottom is made from optional tinplate (per QQ-T-425) or terneplate (per QQ-T-191). A double seam joint is used to secure the bottom to the body. A material meeting MIL-S-11388 is used to seal the joint against moisture. The 0.50-inch-diameter vent hole in the M-18 design is unnecessary with the proposed design and was therefore eliminated.

3. TOP ASSEMBLY

The top assembly is identical to that used on the M-18 grenade. The material for the top design is the same as that used on the M-18, with optional tinplate, or terneplate.

A threaded brass adapter, welded to the center of the top, provides for fuze attachment. A material meeting MIL-S-11388 is applied to the lip to provide a moisture seal after the top is crimped to the body.

4. CHIMNEY

The chimney is made from 2011-T3 aluminum alloy, a widely used screw machine material. The properties of this alloy are as follows:

Tensile strength (psi)	55,000
Yield strength (psi)	43,000
Elongation (% in 2 in.)	15
Shear strength (psi)	32,000

Endurance limit (psi)	18,000
Brinell hardness	95
Modulus of elasticity (psi)	10.2×10^6
Specific gravity	2.82
Melting range (°F)	995 to 1190

In addition to providing an outlet for the smoke, the chimney forms a bulkhead between the ballute and smoke grain, supplies the attachment points for the ballute and allows the fuze output to reach the smoke first fire. A groove on the chimney outer perimeter permits the outer can to be attached by a 360-degree roll crimp. The eight, .12 diameter holes are provided in the bulkhead wall to allow a small portion of the smoke to pressurize the ballute.

5. BALLUTE ASSEMBLY

The aerodynamic retardation and floating capability is provided by a gas-filled ballute constructed from two flat, circular pieces of silicone rubber coated glass fabric. The two sheets are sewn together at the outer periphery and retained by plates on the I.D. The chimney forms the inside gas seal as shown in Figure 1. Gases bleed from the burning smoke composition through vent holes in the bulkhead of the chimney, filling the ballute and expanding it into a tight toroidal ring. The ballute is sized to provide sufficient aerodynamic retardation to prevent the grenade from sinking in either water or mud. After contact with the water, the ballute remains inflated, providing a floating collar. The center of gravity of the floating unit is below the center of buoyancy, thus keeping the grenade in an upright attitude. The concept described above also has been successfully used on the 40-mm TMF-1 as well as the LUU-8/B, -10/B, and -11/B rescue markers.

The ballutes were fabricated and subsequently sewn by an outside vendor for the delivery units. Talc was used on the ballute material for the delivery units because sticking of the ballute material presented a problem during environmental tests. The vendor also indicated a need for the talc for sewing purposes. The reduced diameter for the ballutes from twelve inches to ten and one-half inches on the delivery units relieved the installation packing problem a significant amount. Ballute hardware, on the delivery units, had specific sharp corners removed because the environmental functioned units had evidence of ballute cuts and impressions from these sharp corners. The importance of removal of all sharp corners was evidenced during the manufacture of the 320 units because the chimney cut a ballute that had been assembled and accidentally dropped. The drawing has been updated to alleviate this problem.

6. INSULATION

The liner insulation (or liner) for the smoke/body interface is made from bleached cotton phenolic tubing, Type FPE, per MIL-P-79. The tube's thickness (.11 inches) was sized to satisfy the following two design requirements:

1. Minimize heat flow from the smoke canister to the water, which would decrease burn rate and smoke volume.
2. Reduce the temperature of the body to prevent grass fires.

This material has been successfully used as a flare case material in a battlefield illumination system and an improved target illumination flare (shielded flare) program.

Type FPE cotton phenolic has the following properties:

Tensile strength (psi)	7,000
Modulus of elasticity (psi)	1,000,000
Compressive strength (psi)	13,000
Rockwell hardness (M)	M-105
Density (gm/cc)	1.14
Thermal conductivity (calories/ sec/centimeter ² /°C)	7×10^{-4}
Specific heat (cal/gm)	0.35 to 0.40

A longitudinal groove cut into the wall of the insulation sleeve allows a relief for the longitudinal seam along the body.

SECTION III

SMOKE COMPOSITIONS

1. GENERAL

The smoke charge design consists of an ignition starter mix, a ballute inflation mix and the main smoke charge, all pressed simultaneously in the listed order.

The charge is a single end burner 1.5 to 2.7 inches long depending on the smoke color. The violet composition required more free volume to allow for char expansion during burning. The main charge composition is a pressed dye/sodium picrate formulation. The high percentage of dye, approximately 57 percent, offsets the floating grenade's smaller charge weight compared to the standard M-18 (40%). Since the floating grenade envelope and smoke volume output had to compare with the M-18 grenade, the following is a comparison of the two units:

	<u>M-18</u>	<u>Floating Smoke</u>
Smoke charge volume (cu in.)	14.36	7.70 ⁽¹⁾
Burn pattern	Progressive	Neutral
Burn time (sec)	50 to 90	90 min.
Average burn rate (in./sec)	0.013	0.025 ⁽²⁾
Average dye in composition (%)	40	57
Average density (gm/cc)	1.40	1.37 ⁽³⁾

(1) The charge volume for the violet and green are 5.02 cu. in. and 8.50 cu. in., respectively.

(2) The burning rate for the violet and green are .017 inches per second and .030 inches per second, respectively.

(3) The density for the violet is 1.62 gms/cc.

	<u>M-18</u>	<u>Floating Smoke</u>
Smoke composition weight (gm)	330	170 ⁽⁴⁾
Initial surface area (sq in.)	8.95	3.35
Charge length (in.)	3.5	2.3 ⁽⁵⁾

The introduction of the ballute mechanism into the M-18 envelope, however, did require some sacrifice in charge length. The smoke length is reduced from the 3.5 inches in the M-18 to 1.5 to 2.7 inches. This reduction in smoke charge length did not materially affect the smoke cloud visibility. See Appendix A.

The three charge components were developed through an extensive series of tests listed in the Appendixes. Details of the three elements of the smoke charge are discussed in the following paragraphs.

2. IGNITION STARTER MIXTURE

The Boron Potassium Nitrate starter mixture gave excellent results throughout the duration of the program. It had a 100 percent reliability in igniting the inflation mix. However, the initial weight of 5.8 grams used on the first units was reduced to 3 grams early in the program to prevent burning of the ballute and "flaming" of the smoke cloud.

3. INFLATION MIX

Only the red and green grenades used nitrocellulose ball powder in the inflation mixes through the environmental function tests. The environmental function tests pointed up the need of ball powder in all units because of the burning of the ballutes, particularly with colors white and yellow that did not have the ball powder in the inflation mix. All delivery units used ball powder in the inflation mix. Since ball powder has been incorporated in all inflation mixes, no burn problems occurred on the ballutes during function tests.

4. SMOKE COMPOSITION

During the developmental phase of this program, prior to producing the 320 grenades, the smoke composition was made up in

(4) The composition weight for the violet and green are 130 grams and 185 grams, respectively.

(5) The charge length for the violet and green are 1.5 inches and 2.7 inches, respectively.

1000g batches or less. The production of 320 grenades (64 of each color) was made up in approximately twenty-pound batches. Tests were made prior to pressing this material for the production of 64 of each color. It was found that the burn time characteristic was not the same. The mixes were altered by adding more sodium picrate. SMP-60, Data List-040688000, covers this procedure in detail. The drawings indicate the need to adjust formulations to satisfy burning time. The net result of changes was as follows:

<u>Color</u>	<u>% Sodium Picrate 1000g Mix</u>	<u>% Sodium Picrate Production Mix</u>
White	38	39
Green	37	37.5
Yellow	39	39.6
Red	38	38.0 (No Change)
Violet	38	38.0 (No Change)

As a result of the functional tests on the environmental units, an extensive effort was made before producing 64 units to reduce the possible effect of vibration. During the course of this effort, it was found that a comparable weight of the violet smoke composition to the other colors yielded erratic results in burning of the smoke compositions. This erratic effect was most noticeable in severe chuffing as well as short burning duration. Increased pressing pressure alleviated the vibration problem and reduced smoke composition weight yielded a smoother flow of smoke from the chimney while maintaining minimum burn times.

Another problem encountered with the violet smoke mix was a large char expansion during burning. It was reasoned that the char expansion in a confined space above the smoke mix causes a pressure buildup against the charge, increasing its burning rate. To alleviate this condition, a large gap (1.25 inches) was left between the face of the starter mix and the chimney.

Difficulty in the green color "washing out" or filterning during burning resulted in the use of a foam-filled hole. This hole, a half-inch diameter drilled through the center of the charge, was filled with an Flexipol RP5 Polyurethane foam⁽¹⁾. This hole allowed the smoke to vent inward from the burning surface, thus, bypassing the char layer.

(1) Trade name of Flexible Products Company, Marietta, Georgia.

Details of the composition tailoring and other problem solving efforts can be found in Appendixes B, C, D, E, and F.

The compositions of the various mixes are listed in Appendix G.

SECTION IV

-12-

TEST RESULTS

1. DEVELOPMENT TESTS

In addition to the extensive smoke formulation work described in Section III, the ballute made up the balance of the development tests. Early tests were conducted with the silicone coated cotton material which was used on the early 40-mm TMF-1 design. Difficulties were experienced in tears and burns. Packaging of the ballute in the small space available proved to be troublesome. Changes were made to the chimney and phenolic asbestos spacers to help eliminate these problems. In addition, the ballute diameter was reduced from 12 inches to 10.5 inches.

After the feasibility demonstration tests were conducted, three silicone fiberglass ballute materials were tested. Fourteen ballute assemblies were tested using the SRG 0610, RM-7 and RM-5 silicone coated fiberglass material. All ballute systems functioned perfectly.

The fiberglass material selected for use in the 85 environmental test units is designated RM-7. This material had adequate strength and heat resistance to withstand the starter mix ignition and ballute inflation requirements of the floating grenade. The increased heat resistance of the RM-7 material permitted the continued use of the more reliable BKNO_3 first fire and therefore eliminated further testing of black powder for starter mix. The 0.004 inch glass cloth thickness is coated on both sides with silicone rubber giving a total weight of 7.5 oz./sq. yd. This material was easily packaged in the fully assembled grenade.

Test data from 3M Company indicates that this material is flexible after being subjected to -70°F for five hours, is non-corrosive in normal use and shows no cracking in a bend test after being subjected to 450°F for 24 hours.

All environmental and delivery units were fabricated with the RM-7 ballute material. Results of the ballute testing are summarized on Table II.

TABLE II
SILICONE RUBBER COATED FIBERGLASS BALLUTE MATERIAL TESTS

Test No.	Date	Ballute Material	Glass Thickness (in.)	Coated Thickness (in.)	Smoke Color	Land or Water Test	Burn Time (sec)	Remarks
1	3-9-71	RM-5	0.002	0.005	Yellow	Land	Not Recorded	Small tear holes, but stayed inflated. Will use thicker material.
2	3-9-71	SRG 0610	Unknown	0.010	Green	Land	"	Good, a little too thick.
3	3-9-71	SRG 0610	Unknown	0.010	Violet	Land	"	Reused ballute from Test No. 2, good.
4	3-10-71	SRG 0610	Unknown	0.010	Green	Land	"	Good.
5	3-10-71	SRG 0610	Unknown	0.010	Green	Land	"	Good.
6	3-10-71	SRG 0610	Unknown	0.010	White	Land	"	Good.
7	3-11-71	SRG 0610	Unknown	0.010	Green	Land	"	Reused ballute from Tests 2 & 3. Good.
8	3-11-71	SRG 0610	Unknown	0.010	Yellow	Land	"	Reused ballute from Test 4, good.
9	3-11-71	SRG 0610	Unknown	0.010	Violet	Land	"	Reused ballute from Test 5, good.
10	3-11-71	SRG 0610	Unknown	0.010	White	Land	"	Reused ballute from Test 6, good.
11	3-25-71	RM-7	0.004	0.007	Yellow	Water	129	Good. No burns or tears, packs easier than
12	3-25-71	RM-7	0.004	0.007	Green	Water	114	Good. either cotton
13	3-25-71	RM-7	0.004	0.007	Red	Water	150	Good, or SRG 0610.
14	3-25-71	RM-7	0.004	0.007	Violet	Water	97	No function, fuze failure.
15	3-25-71	RM-7	0.004	0.007	White	Water	----	

2. FEASIBILITY DEMONSTRATION TESTS

A group of thirty-five units was fabricated for the feasibility demonstration phase of the program. Twenty-five units were randomly selected from this group to undergo T&H, wetness and function testing according to the test plan; and the ten remaining units were designated as vendor acceptance test rounds. The ten units were to be leak-tested according to the test plan prior to being function tested.

Three of the ten vendor acceptance test units leaked when they were subjected to 3 psig and submerged under water. The entire surface of the tape and the edges of the tape were coated with clear acrylic lacquer. After the lacquer was dried, the three units were leak-tested again and none of the three units leaked. Lacquer was applied to the 25 demonstration units as described above.

Sixteen of the demonstration units were put into individual fiber containers, and then they were assembled into a shipping box. The packed container was placed in an environmental chamber and subjected to a four-hour temperature soak at 158°F and a T&H cycle approximating the storage and transit conditions of Category 2 of AR70-38. Environmental data are contained in Appendix H.

The remaining nine demonstration units and the 10 vendor acceptance units were placed in covered storage at 70°F. At the end of the T&H cycle, the 17 units were visually inspected, and there was no evidence of any deterioration on the exterior of the units.

A "wet" water solution was prepared by adding 3 pounds of Amway laundry detergent to 10 gallons of water. The 17 units were weighed, and then they were placed in the "wet" water solution. Additional water was added to the tank to provide a hydraulic pressure of 0.5 psig on the units. One hour later, the 16 units were removed from the "wet" water tank, rinsed, dried, and weighed again.

Weight gains were noted in 10/16 of the units. The gains in weight ranged from 0.1 gram to 2.9 grams. (See Appendix H). The fuzes were removed from the 7 units which exhibited gains in weight of a gram or more; and, in all cases, the paper pyrotechnic container of the fuze was wet, and water was observed in the upper portion of the chimney on the smoke unit. The only path available for getting water into this part of the unit was through the compressed asbestos fuze gasket. New fuzes were assembled into the 16 units prior to function testing.

On February 15, 1971, five units (one of each color) of the ten vendor acceptance group were tested. The five units were thrown into

a 6-foot diameter by 1-foot deep pool of water. All units sank to the bottom of the pool before they functioned. The units floated to the surface of the water, and they emitted smoke with excellent color, volume and burning times in excess of 90 seconds.

The feasibility of demonstration tests were performed on February 16, 1971, and they were witnessed by Mr. Paul Frosell of LWL. Eight of the 9 control units and 12 of the 16 environmental test units were tested. The test data are presented in Appendix "H". Although several problems were discovered, it was proven that it was possible to make a floating grenade.

3. ENVIRONMENTAL TESTS

Fifty (50) grenades (ten of each of five colors) were subjected to the proposed test matrix. This group of fifty (50) units and an additional group of thirty-five (35) units were functioned and witnessed by Mr. Paul Frosell of LWL. In addition to the tests outlined in the test plan, a Cessna 206 was used to drop seven units from an altitude of approximately 300 feet into Grovestone Lake near Swannanoa, North Carolina.

The results of the function tests were:

1. Red - burn time, smoke volume and color were good on all units.
2. Green - burn time, smoke volume and color were good.
3. Yellow - burn time, smoke volume and color were good, but ballute material was subject to burn holes.
4. White - burn time, smoke volume and color were good, but ballute material was subject to burn holes.
5. Violet - smoke volume and color were good but severe chuffing with one group of tests caused insufficient burn time.
6. The seven units which were air dropped provided full-up ballutes before impacting the water. Descent retardation with full-up ballutes proved effective since all units air dropped functioned well. All five colors were included in the air to surface function test.

As a result of the above problems, the following corrective actions were recommended.

1. Remove all sharp corners from ballute hardware on delivery units.
2. Use talc on ballute material to eliminate sticking of ballute halves to each other. This will allow the ballute to unfold more freely on inflation.
3. Change yellow and white inflation mixes to reduce burning effect on ballute material when the ballute is initially inflated.

The following conclusions were made following the above tests:

1. Red and green grenades are ready for manufacturing.
2. Changes in inflation mixes for yellow and white will allow these grenades to be placed in manufacturing.
3. Run additional tests on violet prior to placing this grenade smoke color in manufacturing.

Comprehensive tables delineating the results of all function tests were incorporated in progress report No. 6.

4. DELIVERY ACCEPTANCE TESTS

Eighty-four units were tested for functional acceptance of the 320 delivery grenades. The results of these tests are included in Appendix I. All units passed the acceptance tests and approval on the delivery units were received.

SECTION V

CONCLUSIONS AND RECOMMENDATIONS

1. The five colors, violet, red, white, green and yellow, are all comparable to the M-18 grenade.
2. All colors have achieved the ninety second minimum burn time level. The burn time is affected by the Sodium Picrate and must be closely controlled in the processing procedures.
3. BKNO_3 as an ignition composition has shown excellent reliability.
4. The grenades, as data will attest to, have shown good performance. An overall value engineering program could reduce production costs without affecting the performance characteristics.
5. Ballute material and assembly, including the sewing, provides a unit that exhibits good flotation, descent retardation and strength upon inflation.
6. Ballute assembly should have a value engineering study made at an early date. Costs can be reduced by:
 - a) Replacing screws with rivets.
 - b) Redesign chimney for die casting.
7. The manufacturer of smoke grenades should be advised by the user of the optimum length of grenade can assembly.

APPENDIX A

DATA FOR COLOR COMPARISON UNITS

APPENDIX A

<u>Color</u>	<u>Burning Time, Sec</u>		<u>Color</u>		<u>Remarks</u>
	<u>M-18</u>	<u>Floating M-18</u>	<u>M-18</u>	<u>Floating M-18</u>	
White	200	120	Diagy white	White	M-18 flamed for 200 seconds
Green	---	118	Dark green	Aqua	Fuze failed on M-18; first trial
Violet	84	104	OK	OK	Top spacer was twisted on floating M-18 - burned ballute
Red	97	103	OK	OK	Burned hole in bottom of ballute
Yellow	55	106	OK	OK	

APPENDIX B

GREEN SMOKE DATA

APPENDIX B

FLOATING SMOKE GRENADE

DATA SHEET

GREEN SMOKE DATA

Serial No.	Test Date	Percent Composition		Percent Additives	Increment Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remark:
		Dye	NaPic									
G-1	1/12/71	53	47	-	150	5	150	N/A	38	Land	N/A	Dye composition: 70% solvent green 3/30% vat yellow 4. Color and volume excellent.
G-2	1/12/71	58	42	-	170	5	170	N/A	38	L	N/A	Dye composition: 70% solvent green 3/30% vat yellow 4. This smoke mix was made by adding dye to a portion of the mix used for G-1. L = 2.42"
G-3	1/13/71	62	38	-	170	5	170	N/A	75	Land	N/A	Out at 67 sec. Low volume at beginning. Dye composition: 70% solvent green 3/30% vat yellow 4. L = 2.4"
G-4	1/13/71	58	42	-	170	5	170	N/A	-	Land	N/A	Chimney blew off at ignition - 7" char grew from grain. L = 2.35"
G-5	1/13/71	60	40	-	170	5	170	N/A	85	Land	N/A	Dye composition: (7 green/2 yellow 1 benzanthrone). Went out immediately after ignition - restarted by blowing into chimney.
G-6	1/13/71	60	40	-	170	5	170	N/A	81	Land	N/A	Same batch of mix as G-5. Left gap between bottom of chimney and first fire. Went out immediately after ignition.

FLOATING SMOKE GRENADE

DATA SHEET

GREEN SMOKE DATA

Serial No.	Test Date	Percent Composition		Percent Additives	Increment Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuse Delay Time (sec)	Configuration and/or Remark
		Dye	NaPic									
G-7	1/13/71	60	40	-	175	3	175	N/A	-	Land	N/A	Hand-mixed batch. Dye composition 50% green/50% yellow. Chimney blew off at 67 sec.
G-8	1/15/71	62	38	-	170	3	170	N/A	97	Land	N/A	Dye ratio: 50/50: Vat yellow/green 3. L = 2.4". Volume low at start then o.k. Color excellent at start but faded. Lots of chuffing. Ash very hard.
G-9	1/15/71	62	38	2 NaHCO ₃	170	3	170	N/A	102	Land	N/A	Dye ratio - 50/50: Vat yellow/green 3. Volume low at start, then o.k. Color started to fade at T _b - 30 sec. Ash was very hard. L = 2.3".
G-10	1/15/71	62	38	-	170	3	170	N/A	121	Land	N/A	Same batch of mix as G-8. 1/2" diameter hole thru center filled with Flexipol RP-5. NOTE INCREASE IN T _b . Color good. Hard to tell about volume due to high wind. Ho thru center partially plugged - ash was very hard.

DATA SHEET

FLOATING SMOKE GRENADE

GREEN SMOKE DATA

Serial No.	Test Date	Percent Composition		Percent Additives	Increment Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
G-11	1/15/71	60	38	2 NaHCO ₃	170	3	170	N/A	127	Land	N/A	Same batch of mix as G-9. 1/2" diameter hole thru center filled with RP-5. <u>NOTE INCREASE IN T_b</u> . Color was excellent. Volume was low. Hole was perfectly clear.
G-12	1/18/71	58	40	"	170	3	170	N/A	81	Land	N/A	1/2" diameter hole thru center fill with RP-5. L = 2.65". Color and volume excellent.
G-13	1/18/71	58	40	"	170	3	170	N/A	81	Land	N/A	Same as G-12.
G-14	1/19/71	56	40	4 NaHCO ₃	170	3	170	N/A	86	Land	N/A	1/2" diameter hole thru center filled with Flexipol RP-5 foam. Color and volume excellent - lots of chuffing.
G-15	1/19/71	59	39	2 NaHCO ₃	170	3	170	N/A	109	Land	N/A	1/2" diameter hole thru center filled with Flexipol RP-5 foam. Color and volume excellent. Lots of chuffing.
G-16	1/19/71	58	38	2 NaHCO ₃ 2 Ball Pwdr.	170	3	170	N/A	105	Land	N/A	1/2" diameter hole thru center filled with Flexipol RP-5 foam. Color and volume excellent. Smoothest pouring green to date.

FLOATING SMOKE GRENADE

DATA SHEET

GREEN SMOKE DATA

Serial No.	Test Date	Percent Composition		Increment Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuse Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic								
G-17	1/20/71	58	38	20/170	3	190	-	96	Land	N/A	Ballute blew off on ignition - chimney stayed in place. Ballute inflation comp. - 20% green dye, 20% yellow, 60% sodium picrate. First fire was cracked on top of smoke grain. RP-5 filled 1/2" diameter hole thru center.
G-18	1/20/71	58	38	20/170	3	190	1	97	Land	N/A	Used No. 5100-62 Truarc snap ring to hold ballute top on. Inflated immediately and remained so for total burn, but was not extremely tight. Same inflation comp. as G-17. Hole thru center as G-17.
G-19	1/21/71	58	37	20/170	3	190	-	108	Land	N/A	Inflation comp. = 23.5% green dye, 23.5% yellow, 50% NaPic, 3% ball powder. RP-5 filled 1/2" diameter hole thru center. Color and volume excellent. Blew the top half of the ballute off the chimney.
G-20	1/21/71	58	37	20/170	3	190	-	106	Land	N/A	Same inflation com. as G-19. Same grain configuration as G-19. Ballute burst where the upper and lower halves were stitched together.

DATA SHEET

FLOATING SMOKE GRENADE

GREEN SMOKE DATA

Serial No.	Test Date	Percent Composition		Additives	Increment Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remark
		Dye	NaPic									
G-21	1/22/71	58	37	2.5 Ball Pwdr. 2.5 NaHCO ₃	20/144	3	164	1	97	Land	N/A	Inflation comp. = 25.5% yellow dye, 25.5% green dye, 46% NaPic, 3% ball powder. Used Truarc snap ring to hold ballute on chimney. Immediately after the ballute inflated, the upper half of the ballute split. Post-fire examination of the ballute showed that the ballute had been assembled improperly. Same smoke mix as G-19 and -20. RP-5 filled 1/2" diameter hole thru center.
G-22	1/22/71	58	37	"	20/150	3	170	1	100	Land	N/A	Same inflation comp. as G-21. Us new upper spacer to provide a good bonding surface for the upper ballute half. Ballute inflated immediately and remained so for the entire event. Ballute was in perfect condition at the end of the event. RP-5 filled 1/2" diameter hole thru center.
G-23	1/22/71	58	37	"	20/150	3	170	1	102	Land	N/A	Same configuration as G-22. Used Truarc snap ring as ballute retainer. Ballute results same as G-22.

DATA SHEET

FLOATING SMOKE GRENADE

GREEN SMOKE DATA

Serial No.	Test Date	Percent Composition		Percent Additives	Increment Weights (gms)	Fires-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remark
		Dye	NaPic									
G-24	1/22/71	58	37	2.5 Ball Pwdr. 2.5 NaHCO ₃	20/161	3	181	1	102	Land	N/A	Same batch of inflation comp. and smoke mix as G-22 and -23. Ball up immediately. Upper half of ballute pulled loose from upper spacer at one edge at 90 sec.
G-25	1/26/71	58	37	"	170	3	170	N/A	104	Land	N/A	Dye composition: 50% carey green 50% Atlantic yellow. No hole thru center.
G-26	1/26/71	58	37	"	170	3	170	N/A	120	Land	N/A ^q	Same batch of smoke mix as G-25. RP-5 filled 1/2" diameter hole thru center. Color excellent. Foam cured 4 hours.
G-27	1/26/71	58	37	"	170	3	170	N/A	120	Land	N/A	Same as G-26.
G-28	1/28/71	58	37	"	150	3	150	N/A	89	Land	N/A	Pressed first fire end up. Gap of 0.4" between first fire and chimney. Color was poor.
G-29	1/30/71	58	37	"	20/170	3	190	1	118	Land	2	Unit for filming color comparison test with M-18 unit. Made with RF filled 1/2" diameter hole thru center. M201A1 fuse failed on their unit. placed their unit with a spare we had on hand. Their color was excellent. Out color was different.

APPENDIX C

RED SMOKE UNIT DATA

APPENDIX C

FLOATING SMOKE GRENADE

DATA SHEET

Red Smoke Data

Serial No.	Test Date	Percent Composition		Percent Additives	Incremental Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflation Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuse Delay Time (sec)	Configuration and/or Remarks
		Dye	NAFIC									
R-1	11/30/70	52	38	10	201	5.8	201 BRB1-I TRB2-I	--	102	land	--	Color excellent for first 30 seconds of run, then faded for rest of run.
R-2	12/1/70	52	38	10	201	5.8	201 BRB1-I TRB2-I	--	101	land	--	Same as R-1
R-3	12/3/70	52	38	5 - ball powder 5 - sulfur	21/180	1.0 gm pressed in center	201 BRB2-I TRB2-I	in-stantly	108	land	--	12-inch diameter ballute. 8-1/8 inch dia. vents. Small hole in top of ballute at point of contact with retaining ring. Leak down seam of can. Two-inch diameter upper spacer. Grain length = 2.73 in.
R-4	12/3/70	52	38	5 - ball powder 5 - sulfur	21/180	1.0 gm pressed in center	11 BRB2-I TRB2-I	30	103	land	--	12-inch diameter ballute. 8-1/8 inch diameter vents. Used 2 each 2 in. diameter x .050 in. thick RPD spacer to sandwich the ballute. Ballute did not tear loose. Grain length = 2.71 in.
R-5	12/3/70	52	38	5 - ball powder 5 - sulfur	21/180	5.8	201 BRB2-I TRB2-I	30	102	land	--	Same as R-4 configuration. Grain length = 2.83 in.

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DATA SHEET

FLOATING SMOKE GRENADE

Red Smoke Data

Serial No.	Test Date	Percent Composition		Percent Additives	Incremental Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	API									
R-6	12/3/70	52	38	5 - ball powder 5 - sulfur	21/180	5.8	11 BRB2-1 in- TRB2-1 flated	never	112	land	--	Same configuration as R-4. Piece of slag fell on top of ballute and burned a hole in it. Grain length - 2.80 in.

FLOATING SMOKE GRENADE

DATA SHEET

Red Smoke Data

Serial No.	Test Date	Percent Composition	Percent Admixtures	Incremental Weights (gms)	First-Fire Weight (gms)	Total Composition (gms)	Ballistic Data	Time of Flight (sec)	Time of Burst (sec)	Time of Delay (sec)	Configuration, and/or Remark
R-7	12/8/70	52.38	5 ball powder 5 sulfur	21/180	2 gm top red in acetone	201 BRB2-1 TRB2-1	N/A	105	Land	N/A	Drilled 1/2-in. dia. hole through center of grain. Filled the hole with flexipol polyurethane foam. Grain was at room temperature when foamed. Foam was soft. Char was extracted from insulation and sectioned. It was plugged with char from bottom to 1/2 way up grain. Middle to top was clear. No dramatic improvement in color. Length of grain = 2.7 in.
R-8	12/9/70	52.38	5 ball powder 5 sulfur	21/180	5.8	BRB1-1 TRB2-1 201	N/A	107	Land	N/A	Mixed BRB1-1 in Lancaster Muller additional 10 minutes. Color good as M-18. Grain length 2.95 in.
R-9	12/9/70	52.38	5 ball powder 5 sulfur	21/180	5.8	BRB1-1 TRB2-1	N/A	107	Land	N/A	Drilled 1/2-in. dia. hole through center of grain and filled with Phillips-Foscue foam. No improvement in color. Grain length 2.9 in.

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N/A = Not applicable
 ** NCI batch numbers

FLOATING SMOKE GRENADE

DATA SHEET

Red Smoke Data

Spec. No.	Test Date	Percent Composition		Additives	Incremental Weights (gms)	Filling Time (mins)	Total Composition Weight (gms)	Ballute Inflation Time (sec)	Solid Matter (gms)	Land or Water	N/A	Configuration and/or Remarks
		Ballute	Charge									
R-10	12/14/70	52	36	5 sulfur 5 ball powder	10/180	2.5	190 TRB2-1 BRB3-1	1	128	Land	N/A	1 1/2-in. dia. orifice; 8-1/8-in. dia. vents. Top ballute half was cut to form 4 spokes. Ballute droopy between spokes. Ballute survival excellent. Length of grain = 2.68 Wet mix process. Used carey red - color not good (pink).
R-11	12/14/70	54.5	40	5.5 NaHCO ₃	10/180	2.5	190 TRB2-1 BRB4-1	1	114	Land	N/A	Dye a mixture of red 9/dextrin. Color not good (pink). Used same ballute system as R-10. Grain length = 2.55 in.
R-12	12/16/70	52	36	5 sulfur 5 ball powder	20/180	2.5	200 TRB2-1 BRB5-1	Partial 1	122	Land	N/A	Used 2 long slots for inflation vents. Never fully inflated. 1/2-in. dia. orifice. 12-in. dia. ballute. Grain length = 2.84 in. Wet mix process seems to cool the composition (probably due to dissolving the ball powder and uniformly coating the picrate and smoke with N. C.).

FLOATING SMOKE GRENADE

DATA SHEET

Red Smoke Data

Serial No.	Test Date	Percent Composition	Ingredients	Increment Weights (gms)	First-Fire Weight (gms)	Total Composition (gms)	Ballistic Index	Time (sec)	Time of Water Test	Time Delay (sec)	Configuration and/or Remarks
R-13	12/16/70	52 38	5 sulfur 5 ball powder	30/100	2.5	130 TRB2-1 BRB5-1	Partial	Did not record	Land	N/A	Increased amount of inflation composition by 50%. 1/2-in. diameter orifice. 2 slots for inflation vents. Same ballute as R-12. Ballute inflated but not extremely tight. Unit would have floated.
R-14	12/16/70	52 38	5 sulfur 5 ball powder	20/100	5.8	120 TRB2-1 BRB5-1	1	Did not record	Land	N/A	Increased amount of first fire to 100%. Ballute up instantly, deflated, did not inflate tight for rest of event. 1/2-in. dia. orifice 2 slots for inflation.
R-15	12/17/70	52 38	5 sulfur 5 ball powder	20/100	2.5	120 TRB2-1 BRB5-1	1	Did not record	Land	N/A	11/32-in. dia. orifice. 8-1/8-in. dia. inflation vents. 12-in. dia. ballute. Ballute up immediately - deflated - did not get back up tight for rest of event.

FLOATING SMOKE GRENADE

DATA SHEET

Red Smoke Data

Serial No.	Test Date	Percent Composition		Additives	Incremental Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gms)	Filling Method	Time (sec)	Total Burn Time (sec)	Time of Water Test	Average Delay Time (sec)	Configuration and/or Remarks
		Time	Material										
R-16	12/17/70	52	38	5	20/180	2.5	200	TRB2-1	1	107	Land	N/A	Same ballute as R-15. Inflated immediately deflated, up tight in 30 sec. and stayed for remainder of event. Grain length = 2.9 in Used dry mix composition.
				sulfur 5 ball powder			TRB1-1						
R-17	12/18/70	52	38	5	20/180	2.5	200	TRB2-1	1	98	Land	N/A	Used 1/4-in. dia. orifice in chimney. Inflated immediately - stayed up for entire event. Ballute system survival excellent.
				sulfur 5 ball powder			BRB6-1						

FLOATING SMOKE GRENADE
RED SMOKE DATA

DATA SHEET

Serial No.	Test Date	Percent Composition		Percent Additives	Increment Weights (gms)	Weight (gms)	Total Composite Weight (gms)	Ballute Inflated Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
R-18	1/2/71	52	38	5 Sulfur 5 Ball Pwd.	21/180	5	201	41	91	Land	2	1 1/2" diameter ballute. 8-1/8" dia vents. Drilled 1/2" diameter hole center of grain and filled with RP-5 foam in attempt to improve Color was poor. Ballute tore too at top at 70 sec. Color was not improved.
R-19	1/5/71	52	38	"	21/180	5	201	N/A	56	Land	N/A	No ballute. Color still poor. Ex volume. Obviously center perf. burned. 1/4" orifice. 0.5 diameter hole thru center-filled with RP-5.
R-20	1/5/71	52	38	"	20/175	5	195	N/A	96	Land	N/A	No ballute. No hole thru center. This unit to refresh memory on color without hole thru center. Color was not good. L = 2.75".
R-21	1/7/71	57	38	5 Sulfur	20/175	5	195	N/A	270	Land	N/A	1/4" diameter orifice. Volume p for 120 sec Color was much improved. Would not have kept ball inflated.
R-22	1/7/71	57	38	5 Sulfur	20/175	5	195	N/A	-	Land	N/A	Drilled 1/4" diameter hole thru center of grain. Chimney blew off at ignition. Unit flamed. No sur inhibited.

FLOATING SMOKE GRENADE

DATA SHEET

RED SMOKE DATA

Serial No.	Test Date	Percent Composition		Percent Additives	Increment Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remark
		Dye	Napic									
R-23	1/11/71	57	38	5 Sulfur	20/134	5	154	N/A	180	Land	N/A	L = 2.1". Drilled 1/2" diameter long hole in first fire end of grain volume. Good color.
R-24	1/12/71	55	45	-	150	5	150	N/A	62	Land	N/A	Color excellent 15 sec, faded to orange, then dull brown. Solid grain.
R-25	1/12/71	55	42	3 Sulfur	150	5	150	N/A	96	Land	N/A	Color excellent for 30 sec, then faded to orange. Solid grain.
R-26	1/12/71	54	38	5 Sulfur	170	5	170	N/A	123	Land	N/A	Volume excellent. Color faded to pink at 30 seconds. Dry mix process. Solid grain.
R-27	1/13/71	54	38	5 Sulfur 3 Ball Pwdr.	170	5	170	N/A	126	Land	N/A	Volume excellent. Best color for 90 sec to date. 1/2" diameter hole thru center filled with flexipol RP foam. L = 2.45". Dry mix process.
R-28	1/18/71	54	33	5 Sulfur 3 Ball Pwdr.	170	3	170	N/A	154	Land	N/A	Used wet mix process. 1/2" diameter hole thru center-filled with Flexipol RP-5 foam. Volume low at beginning. Color excellent for 75 sec - faded some but was acceptable for entire burn time.

FLOATING SMOKE GRENADE

DATA SHEET

RED SMOKE DATA

Serial No.	Test Date	Percent Composition		Percent Additives	Incremental Weights (gms)	F at-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuse Delay Time (sec)	Configuration and/or Remark
		Dye	Maple									
R-29	1/18/71	54	38	5 Sulfur 3 Ball Powder	20/170	3	190	N/A	157	Land	N/A	Volume low at beginning. Smoke vented thru inflation vents for the entire run. 1/2" diameter hole in center of grain filled with Flexipc RP-5. Color completely acceptal
R-30	1/20/71	54	38	5 Sulfur 3 Ball Pwdr.	20/170	3	190	-	150	Land	2	Burned hole in top and bottom of ballute upon impact with ground. C new method of packing ballute. C and volume excellent.
R-31	1/20/71	54	38	5 Sulfur 3 Ball Pwdr.	20/170	3	190	1	154	Land	2	Ballute up instantly and remained so for total burn time. Color and volume excellent.
R-32	1/20/71	54	38	5 Sulfur 3 Ball Pwdr.	20/170	3	190	1	157	Land	2	Ballute up instantly and remained so for total burn time. Color and volume excellent.
R-33	1/25/71	54	38	5 Sulfur 3 Ball Powder	180	3	180	N/A	83	Land	N/A	RP-5 filled 1/2" diameter hole th center. Foam cured 1/2 hr. using new shipment of dye from Atlantic Chemical Co.

DATA SHEET

FLOATING SMOKE GRENADE

RED SMOKE DATA

Serial No.	Test Date	Percent Composition		Percent Additives	Increment Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuse Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
R-34	1/26/71	54	38	5 Sulfur 3 Ball Powder	170	3	170	N/A	96	Land	N/A	No hole thru center. No extra gas between first fire and bottom of chimney. Used new Atlantic red dye.
R-35	1/26/71	54	38	5 Sulfur 3 Ball Powder	170	3	170	N/A	98	Land	N/A	Same batch of smoke mix as R-34. RP-5 filled 1/2" diameter hole thru center. Color faded to pink at 60 sec. New Atlantic red dye.
R-36	1/26/71	54	38	"	170	3	N/A	99	Land		N/A	Same as R-35.
R-37	1/27/71	55	38	5 Sulfur 2 Ball Powder	175	3	175	N/A	93	Land	N/A	RP-5 filled 1/2" diameter hole thru center. Color faded at end. volu excellent. New Atlantic red dye.
R-38	1/27/71	55	38	"	175	3	175	N/A	95	Land	N/A	Same as R-37.
R-39	1/27/71	55.5	38	5 Sulfur 1.5 Ball Powder	175	3	175	N/A	104	Land	N/A	RP-5 filled 1/2" diameter hole thru center. New Atlantic red dye.
R-40	1/27/71	"	"	"	175	3	175	N/A	99	Land	N/A	Same as R-39.

FLOATING SMOKE GRENADE

DATA SHEET

RED SMOKE DATA

Serial No.	Test Date	Percent Composition		Percent Additives	Increment Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	Napic									
R-41	1/27/71	54	38	5 Sulfur 3 Ball Pwdr.	150	3	150	N/A	130	Land	N/A	Pressed first fire up. Gap of 5/ between top of first fire and bottom of chimney. Color and volume excellent. Old Atlantic red dye.
R-42	1/27/71	54	38	"	20/150	3	170	N/A	107	Land	N/A	Gap of 0.4" between top of first fire and bottom of chimney. Same batch of mix as R-34, -35, and -
R-43	1/27/71	55.5	38	5 Sulfur 1.5 Ball Pwdr.	20/150	3	170	N/A	94	Land	N/A	Gap of 0.4" between top of first fire and bottom of chimney. Same batch of mix as R-39 and R-40.
R-44	1/30/71	54	38	5	20/150	3	170	-	103	Land	2	Unit for filming color comparison with M-18. Colors of both units were approximately the same. Burned hole in bottom of ballute when unit blew off the stand at ignition. M-18 burned 97 sec.

APPENDIX D

VIOLET SMOKE UNIT DATA

APPENDIX D

FLOATING SMOKE GRENADE

DATA SHEET

Violet Smoke Data

Serial No.	Test Date	Percent Composition	Percent Additives	Weight (gms)	Weight (gms)	Composition	Grain Length (in.)	Time (sec)	Land or Water	Time (sec)	Configuration and Remarks
V-1	12/28/70	56 34 5	sulfur ball powder	0/150	2.5	150 BUB1-I	N/A	14	Land	N/A	1 1/4-in. dia. orifice. Smoke extinguished in 14 seconds. Grain length 2.14 inches.
V-2	12/28/70	54 36 5	sulfur ball powder	0/150	2.5	150 BVB2-I	N/A	54	Land	N/A	1 1/4-in. orifice. Chimney blew off at TB = 54 sec. Grain length = 2.12 in.
V-3	12/29/70	57 38 5	amm. CIO ₄ (400 μ)	0/150	2.5	150 BVB3-I	N/A	67	Land	N/A	1 1/4-in. dia. orifice. Chuffed periodically throughout event. Bottom of can domed during run. Grain length = 1.96 in.
V-4	12/29/70	57 38 5	Benz-anthrone	0/150	2.5	150 BVB4-I	N/A	100	Land	N/A	1 1/4-in. dia. orifice. Chuffed periodically throughout event. Char hard on top, soft on bottom. Grain length = 2.01 in.

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FLOATING SMOKE GRENADE

DATA SHEET

Violet Smoke Data

Serial No.	Last Date	Percent Composition		Percent Additives	Increment	Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballistic Initiat. Time (sec)	Total Burnt Time (sec)	Land or Water	Test	Time Delay	Comments and/or Remarks
V-5	12/29/70	57	38.5	oxamide	0/150	2.5	150	BVB5-I	N/A	104	Land	N/A	N/A	Same as V-3. Grain length = 1.98 in.
V-6	12/29/70	57	38.5	Benzanthrone	0/150	5	150	BVB6-I	N/A	77	Land	N/A	N/A	1/4-in. dia. orifice. Sieved NaPic through 30-mesh screen prior to mixing. Left a void of ~1-in. high and 2-in. dia. between first fire and bottom of chimney. Unit burned smoothly. Low volume at beginning. Red dye visible at low volume. 56 gm of 150 gr comp. did not burn. Char was soft. Laminations in press problems?
V-7	12/30/70	57	38.5	Benzanthrone	75/75	5	150	BV 7-I We process	N/A	104	Land	N/A	N/A	Used 1/4-in. dia. orifice. Used 0.025-in. thick paper spacer in bottom of insulation sleeve during pressing. Pressed in 2 increments - 5 sec. dwell each increment. X-rayed grain and found no cracks. Almost extinguished at 30 sec. Lots of sputtering. Void space of 0.7 lg. x 2-in. dia. between F.F. and bottom of chimney. Grain length 2.2 in. Lots of sputtering.

FLOATING SMOKE GRENADE

DATA SHEET

Violet Smoke Data

Serial No.	Test Date	Percent Composition		Additives	Increment	Weights (gms)	First-Fire	Weight (gms)	Total	Composition	Ballute Initiat.	Time (sec)	Total Burn Time (sec)	Land or Water	Time Delay	Configuration and/or Remarks
		Type	Value													
V-8	12/30/70	57	38.5	Benzanthrone	150	5	150	BVB7-I	150	N/A	96	Land	N/A	1 1/4-in. dia. orifice. One increment press 15 sec. dwell time. Used paper spacer in bottom of insulation liner while pressing. X-rayed grain - no cracks. Some sputtering during burn. Grain length = 2.2 in.		
V-9	12/30/70	57	38.5	Benzanthrone	20/150	5	170	TVB1-I (50 dye/50 NaPic)	170	1	90 ⁺	Land	1	First complete unit we have made. 1 1/4-in. dia. orifice. Revision B chimney. Used 1 layer of 3-in. wide tape to seal the joint. 1 1/2 dia. ballute. Smoke color and volume good. Ballute was inflated entire event, but not extremely tight. Tape sheared in same plan as crimp. Ballute system survival perfect. Failed to start stop watch at beginning of burn. Length of smoke grain = 2.48 in.		

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DATA SHEET

FLOATING SMOKE GRENADE

VIOLET SMOKE DATA

Serial No.	Test Date	Percent Composition		Percent Additives	Increment Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remark:
		Dye	Napic									
V-10	1/5/71	57	38	5 Benz-anthr-one	20/150	5	170	1	89	Land	2	1 1/2" diameter ballute. Retainer bl off. Ballute up immediately. Aln went out at 70 sec. No extra free space between top of first fire and chimney.
V-11	1/5/71	57	38	"	20/150	5	170	N/A	105	Land	N/A	L = 2.45". 0.35" space between first fire and bottom of chimney. Volume of smoke excellent - color started to fade at 60 sec. Must have head space in unit to give the char a place to go.
V-12	1/6/71	57	38	"	20/150	5	170	1	105	Land	2	Demonstration unit for Mr. Elmer Landis of LWL. Unit was thrown from 50' tower on H.E. range. U: functioned perfectly although it impacted on a concrete slab.
V-13	1/26/71	57	38	"	150	-3	150	N/A	88	Land	N/A	Used new shipment violet dye and benzanthrone from Atlantic Chemic Co. Dye Corp. Was 80 percent ne violet and 20 percent old Atlantic r
V-14	1/26/71	57	38	"	150	3	150	N/A	85	Land	N/A	Same as V-13.

DATA SHEET

FLOATING SMOKE GRENADE

VIOLET SMOKE DATA

Serial No.	Test Date	Percent Composition		Percent Additives	Increment Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remark
		Dye	Napic									
V-15	1/27/71	52	38	10 Benzanthrone	150	3	150	N/A	70	Land	N/A	Solid grain. Dye composition: 8 new Atlantic violet/20% new Atlantic red. Used new Atlantic benzanthrone.
V-16	1/27/71	52	38	"	150	3	150	N/A	61	Land	N/A	Same mix as V-15.
V-17	1/27/71	54.5	38	7.5 Benzanthrone	150	3	150	N/A	61	Land	N/A	Solid grain. Dye composition as V-15. Same benzanthrone as V-15.
V-18	1/27/71	"	"	"	150	3	150	N/A	58	Land	N/A	Same as V-17.
V-19	1/28/71	57	38	5 Benzanthrone	150	3	150	N/A	98	Land	N/A	New batch of smoke mix using carey violet. Used new Atlantic benzanthrone. Pressed first fire up. Gap of 0.4" between first fire and chimney.
V-20	1/28/71	57	38	"	160	3	160	N/A	97	Land	N/A	Same batch of mix as V-19. Pre. first fire end up. Gap of 0.26" between first fire and chimney.

DATA SHEET

FLOATING SMOKE GRENADE

VIOLET SMOKE DATA

Serial No.	Test Date	Percent Composition		Percent Additives	Incremental Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remark
		Dye	NaPic									
V-21	1/30/71	57	38	5	20/150	3	170	-	104	Land	2	Unit made for filming color comparison test with M-18 unit. Smoke color approximately the same for both units. Gap of 0.37' between first fire and chimney. Burned hole in bottom of ballute because upper spacer was twisted and would not allow the ballute to inflate. L = 2.37". M-18 burned 84 sec.

APPENDIX E

WHITE SMOKE UNIT DATA

APPENDIX E

FLUATING SMOKE GRENADE

DATA SHEET

White Smoke Data

Serial No.	Date	Percent Composite		Portals	Weight (gms)	First-Fire Weight (gms)	Total Composite Weight (gms)	Ballistic Data	Time (sec)	Total Burn	Time (sec)	Time of Flight	Configuration and/or Remarks
W-1	12/7/70	62	38	-0-	21/180	5.8	201 BWB1-I TWB1-I	N/A	187	Land	N/A	No ballute. Smoke color gray at chimney - white away from grenade. Sputtered through out run, probably due to incomplete mixing of components. Length of grain 2.73-in.	
W-2	12/8/70	60	40	-0-	21/180	5.8	201 TWB1-I Added NaPic to BWB1-I	N/A	108	Land	N/A	No ballute. Smoke gray in color. Sputterir heard throughout run - absolutely due to plugging in orifice. Grain length = 2.8 in. Not a good white smoke.	
W-3	12/8/70	62	38	-0-	21/190	5.8	211 Added Benzanthrone and NaPic to BWB1-I TWB1-I	N/A	182	Land	N/A	Formulated using 1:1 ratio of white dye: Benzanthrone. Color of the smoke was pale yellow. Benzanthrone does not change Rb appreciably (see W-1). Length of grain = 2.83 in.	
W-4	12/9/70	62	38	-0-	21/180	5.8	201 BWB1-I TWB1-I	N/A	143	Land	N/A	Blended BWB1-I in Lancaster muller for an additional 10 minutes to remove NaPic agglomerates. No sputtering heard during run. Left a hard ash. Smoke was not emitted thru chimney, but out cracks. Grain length = 2.73 in.	

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FLC-111C SMOKE GRENADE

DATA SHEET

(continued)

W-B-10 Smoke Data

Serial No	Test Date	Percent Complete	Address	Incremental Address (gms)	Plat. Time (gms)	Unit	Composition	Weight (gms)	Ballute Defect	Time (sec)	Time (sec)	Time (sec)	Configuration and/or Remarks
W-5	12/9/70	62 38	-0-	21/90	5.6	201	N/A	138	Land	N/A	R _b = 50 sec/in.		Drilled 1/2-inch dia. hole thru center of grain and filled with 2 gm of Phillips-Tosque foam. Grain did not center-perf. burn, smoke color and volume were good. Smoke did emit from chimney and not thru cracks. Soft ash left. Grain length = 2.76 in.
W-6	12/10/70	62 38	-0-	20/47.5	5	167.5	33WB1-I	93	Land	2	R _b = 41 sec/in.		Drilled 1/2 in. dia. hole thru center of grain and filled with flexipol RP-5 foam. Grain may have center perf. burned some. Could not tell if bag was up immediately - did not appear to be. Large hole in top of ballute (burned thru). Length = 2.26 in. Full up unit. Poor volume.
W-7	12/10/70	62 38	-0-	20/180	5	200	BWB2-I TWB1-I	1 96	Land	N/A			Drilled 1/2 in. dia. hole thru center of grain. Filled with flexipol RP-5 foam. Ballute was up immediately. Smoke color and volume excellent. Top of bag tore loose at one place at ~ 70 sec. Still would have floated.

FLOATING SMOKE GRENADE

DATA SHEET

WHITE SMOKE DATA

Serial No.	Test Date	Percent Composition		Additives	Increment Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
W-8	1/6/71	62	38	-0-	20/180	5	200	1	95	Land	2	Demonstration unit for Mr. Land of LWL. Launched from 50' tower at H.E. range. Color and volume good.
W-9	1/25/71	62	38	-0-	20/150	3	170	1	91	Land	2	Unit placed on ground and function. Retainer blew off. RP-5 filled 1/2" diameter hole thru center.
W-10	1/25/71	62	38	-0-	20/150	3	170	1	89	Land	2	Ballute up immediately and stayed up for entire event. 1 1/2" diameter ballute. RP-5 filled 1/2" diameter hole thru center. Ballute perfect
W-11	1/26/71	62	38	-0-	150	3	150	N/A	96	Land	N/A	First white smoke unit using new Atlantic Chemical white dye. RP filled 1/2" diameter hole thru center. Foam cured overnight. Chimney clogged.
W-12	1/26/71	62	38	-0-	150	3	150	N/A	138	Land	N/A	Same batch of smoke mix as W-11. No hole thru center of grain. Orifice plugged. No additional space between first fire and bottom of chimney. Orifice plugged.

DATA SHEET

FLOATING SMOKE GRENADE

WHITE SMOKE DATA

Serial No.	Test Date	Percent Composition		Percent Additives	Increment Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuse Delay Time (sec)	Configuration and/or Remark
		Dye	NaPic									
W-13	1/23/71	60	38	2	150	3	150	N/A	129	Land	N/A	RP-5 filled 1/2" diameter hole thru center. Chimney did not plug. Same batch of smoke mix as W-14. Chimney plugged. RP-5 filled 1/2" diameter hole thru center. It is now obvious that it is very difficult to control the foaming process in the center hole. Orifice plugged.
W-14	1/27/71	60	38	2	150	3	150	N/A	84	Land	N/A	RP-5 filled 1/2" diameter hole thru center. Cured 4 hours. Same as W-15.
W-15	1/27/71	56	39	5	150	3	150	N/A	67	Land	N/A	Pressed first fire end up. Gap of 0.55" between bottom of chimney and top of first fire. Volume low. Chimney did not plug.
W-16	1/27/71	56	39	"	150	3	150	N/A	82	Land	N/A	Pressed first fire end up. Gap of 0.55" between first fire and chimney. New Atlantic dye.
W-17	1/27/71	62	38	-0-	20/150	3	170	N/A	175	Land	N/A	
W-18	1/28/71	60	40	-0-	150	3	150	N/A	85	Land	N/A	
W-19	1/28/71	61	39	-0-	20/150	3	170	N/A	97	Land	N/A	

DATA SHEET

FLOATING SMOKE GRENADE

WHITE SMOKE DATA

Serial No.	Test Date	Percent Composition		Percent Additives	Increment Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	Napic									
W-20	1/28/71	61	39	-0-	20/165	3	185	N/A	94	Land	N/A	Pressed first fire end up. Gap of 0.35" between first fire and chimney
W-21	1/28/71	62	38	-0-	20/150	3	170	N/A	107	Land	N/A	Pressed first fire end up. Gap of 0.53" between first fire and chimney
W-22	1/30/71	62	38	-0-	20/150	3	170	1	120	Land	2	Unit for filming color comparison test with M-8 unit. L = 2.26". Gap of 0.54" between first fire and chimney. Burn time of M-8 = 200 sec. M-8 color is dirty white. Floating smoke color was excellent. Ballute system functioned perfectly. M-8 burns with flame coming from can.

APPENDIX F

YELLOW SMOKE UNIT DATA

APPENDIX F

FLOATING SMOKE GRENADE

DATA SHEET

Yellow Smoke Data

Serial No.	Test Date	Percent Composition		Percent Additives	Increment Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflate Time (sec)	Total Burn Time (sec)	Land or Water Test	Burst Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
Y-1	11/24/70	57	38	5 NaHCO ₃	206.5	5.8	206.5	1	115	H ₂ O	--	One inch O. D. upper spacer; 12-inch ballute; 8-1/8 in. dia. vent holes; 1/2" diameter orifice. Smoke grain length = 2.78 in. Ballute burned through at points of contact with can and at top around chimney. Dull yellow smoke
Y-2	11/25/70	57	38	5 NaHCO ₃	167.0	5.8	167.0	1 partial	122	H ₂ O	--	Two-inch O. D. upper spacer; 12-inch ballute; 8-1/8 in. dia. vent holes; 1/2 in. diameter orifice. Smoke grain length = 2.78 in. Used 2 in. diameter asbestos disc x 0.025 in. thick between retainer and upper ballute half. Partially inflated until last 15 sec of run. Then fully inflated for 1 to 2 seconds. Dull smoke.
Y-3	11/30/70	55	40	5 NaHCO ₃	201.0	5.8	201.0	N/A	112	land	--	Color bright yellow, obviously due to addition benzanthrone dye. Smoke grain 2.81 in. long.
Y-4	11/30/70	56	39	5 NaHCO ₃	199.7	5.8	199.7	1 partial	121	land	--	Ballute only partially inflated for first 10 seconds of run; then fully inflated for remainder of run. Used 2 each .025 in. thick asbestos disc between lower ballute and top of can. Ballute was not burned. 12-inch diameter ballute. 8-1/8-in. diameter vents. 1/2-inch diameter orifice. Smoke bright yellow.

Y-5	12/1/70	56	39	5	209.7	5.8	209.7	<1	94	H ₂ O	
				NaHCO ₃							Ballute inflated immediately. Color bright yellow. 8-1/8 inch diameter vents. 1/2 inch diameter orifice. Used 30 gms inflation composition. 10-inch diameter ballute. Two each .025 in. thick asbestos spacers between can and ballute. Ballute did not burn through. Grain length = 2.76 inches.
Y-6	12/2/70	56	39	5	21/180	5.8	201.0	<1	117	land	12 in. diameter ballute; 8-1/8 in. diameter vents; 0.5 ft diameter orifice; .050 in. thick asbestos between lower spacer and ballute (2 + in. diameter). 2 in. diameter upper spacer smoke color good. Upper part of ballute partially torn away at chimney. Smoke grain length 2.85 in. Total descending wt = 417.8 gm
				NaHCO ₃			BYB2-I TYB1-I				
Y-7	12/2/70	56	39	5	21/180	5.8	201.0	<1	125	H ₂ O	Same configuration as Y-6. Ballute was inflated enough to float unit immediately after ignition. Smoke color good. Upper part of ballute torn away partially at chimney. Smoke grain length 2.87 in. Total descending wt = 413.2 gms.
				NaHCO ₃			BYB2-I TYB1-I				
Y-8	12/2/70	56	39	5	21/180	5.8	201.0	<1	118	land	Same configuration as Y-6. Smoke color good. Upper part of ballute pulled away at chimney. Smoke grain length = 2.86 in. Total descending weight = 416.6 gms.
				NaHCO ₃			BYB2-I TYB1-I				



DATA SHEET

FLOATING SMOKE GRENADE

Yellow Smoke Data

Serial No.	Test Date	Percent Composition		Additives	Increment Weights (gms)	First-Fire Weight (gms)	Total Composition Weight (gm)	Ballute Inflated	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	Ratio									
Y-9	12/2/70	56	39	5 NaHCO ₃	21/180	5.8	201.0 BYB2-1 TYB1-1	Did not inflate	114	land	--	Same configuration as Y-6. Smoke color good. Upper part of ballute pulled away at chimney. Smoke grain length = 2.89 in. Total descending wt = 412.8 gms.
Y-10	12/4/70	56	39	5 NaHCO ₃	21/180	5.8	201 BYB2-1 TYB1-1	Inflated instantly	118	land	--	12-in. diameter ballute. O. D. of chimney reduced to 5.8 in. from 3/4 in. 4-1/8 in. diameter vents + 2 kidney-shaped vents made by drilling out area between two of the 1/8 inch holes. Ballute inflated immediately but tore loose at top of chimney. Smoke grain length was 2.85 in.

APPENDIX G

SUMMARY OF SMOKE COMPOSITION AND
CHARGE CONFIGURATION OF THE
FLOATING GRENADE UNITS

APPENDIX G

Color of Smoke	Dye Content, %					Additives, %			Grain Configuration
	(1) Red	(2) Yellow	(3) Green	(4) Violet	(5) White	(6) Benz- anthrone	Sulfur	Sodium Bicarbonate	
I. Red									
A. Inflation composition	47.5						5	47.5	≈0.5-inch gap between first fire and chimney
B. Smoke composition	54.0						3	38.0	
II. White									
A. Inflation composition				47.5			5	47.5	≈0.55-inch gap between first fire and chimney
B. Smoke composition				62				38.0	
III. Green									
A. Inflation composition	25.5	25.5					3	46.0	0.5-inch diameter hole drilled thru grain center. Hole filled with RP-5 foam.
B. Smoke composition	29.0	29.0					2.5	37.0	
IV. Yellow									
A. Inflation composition	47.5						5	47.5	≈0.5-inch gap between first fire and chimney
B. Smoke composition	20.4						5.0	39.0	
V. Violet									
A. Inflation composition				48.5			3	48.5	≈1.10-inch gap between first fire and chimney
B. Smoke composition				57			5.0	38.0	

(1) Per MIL-D-3284; (2) Per MIL-D-50029; (3) Per MIL-D-3277; (4) Per MIL-D-3691; (5) No MIL Spec.
(6) Per MIL-D-50074

APPENDIX H
ENVIRONMENTAL TEST DATA
FOR
FEASIBILITY DEMONSTRATION UNITS

APPENDIX H
ENVIRONMENTAL TEST DATA
FOR
FEASIBILITY DEMONSTRATION UNITS
T & H TEST DATA

1. Pre-soak: 4 hours required, $157^{\circ}\text{F} \pm 2^{\circ}\text{F}$, $15 \pm 5\%$ RH

Actual (as taken from the Recorder Chart)

<u>Time</u>	<u>Dry Bulb</u>	<u>Wet Bulb</u>	<u>% RH</u>
0930	158	104	16%
1000	158	110	20%
1030	158	112	25%
1100	158	115	27%
1130	158	116	28%
1200	158	118	30%
1230	158	119	31%
1300	158	120	33%
1330	158	122	35%

2. Diurnal

<u>Time</u>	<u>Dry Bulb</u>		<u>Wet Bulb</u>		<u>% RH</u>	
	<u>Required</u>	<u>Actual</u>	<u>Required</u>	<u>Actual</u>	<u>Required</u>	<u>Actual</u>
1400	94	87	N/A	82	80	80%
1700	91	85	N/A	78	84	73%
2000	117	105	N/A	95	74	70%
2300	150	140	N/A	125	30	62%
0200	160	152	N/A	135	10	62%
0500	142	133	N/A	110	35	47%
0800	105	98	N/A	97	59	95%
1100	98	92	N/A	88	75	85%

LEAK TEST DATA
FEASIBILITY DEMONSTRATION UNITS

<u>Color</u>	<u>S/N</u>	<u>W_o, gm</u>	<u>W_f, gm</u>	<u> </u>
Red	2	491.3	491.3	-0-
	3	488.2	491.1	+2.9
	4	490.7	493.3	+2.6
Yellow	2	489.4	490.3	+0.9
	3	490.5	492.2	+1.7
	4	490.8	490.8	-0-
White	2	485.4	487.2	+1.8
	3	490	492.8	+2.8
	4	490	490	-0-
Violet	2	490.4	493.3	+2.9
	3	490	490.1	+0.1
	4	489.5	491.7	+2.2
Green	2	493.8	493.8	-0-
	3	493	493	-0-
	4	491.1	491.2	+0.1
	5	492.8	492.8	-0-

FLOATING SMOKE GRENADE (Air & Surface to Surface)

S/N	Color	Fuze Delay	Burn Time	Ballute Inflation Time	Film	Post Hardware Inspection
1	Yellow	1.5	119	1.5	Yes	Slight chuffing at 1 min. 3 small holes in bottom.
1	Red	3.2	140		Yes	Hit ground - burned ballute.
1	Green	1.6	125		Yes	Chuffing at 69 sec. Ballute o.k. - color good.
1	White	1.7	118		Yes	Ballute twisted at top, burned at bottom.
7	Violet	1.3	108	1.2	Yes	Ballute twisted at top - chuffing at 60 sec. - leak at crimp - holes in bottom.
3	Red					Did not burn - fuze fired - changed fuzes - did not burn.
2	Red	1.2	140			All o.k.
3	Yellow					Did not burn - fuze fired.
2	Yellow	1.3	128			Chuffing at 80 sec. - slight twist on ballute - one small burn hole on bottom.
3	White	1.5	115			Ballute o.k.
2	Violet					Did not burn - fuze fired.
4	Violet	1.6	118			Ruptured ballute.
6	Control Red	1.3	145			Twisted ballute. Burned bottom of ballute.
5	"	1.3	145			Twisted ballute.
5	Control Violet					Straw ignited when first fire spit on it.

FLOATING SMOKE GRENADE (Air & Surface to Surface) (cont'd)

<u>S/N</u>	<u>Color</u>	<u>Fuze Delay</u>	<u>Burn Time</u>	<u>Ballute Inflation Time</u>	<u>Film</u>	<u>Post Hardware Inspection</u>
6	Control Violet	1.3	109			Chuffed at 60 sec. Fireproof test o.k.
	M-18 Violet	1.2	69			Flamed at 40 sec.
6	Control Yellow	1.5	121			Tape did not tear. Chuffed at 90 sec.
5	Control Yellow	1.4	120			Tape did not tear.
6	Control Green	1.5	125			Chuffed at 56 sec. Small hole in bottom of ballute.
5	Control White	1.4	137			Slight twist on ballute.

APPENDIX I

FUNCTION TEST DATA FOR
DELIVERY ACCEPTANCE UNITS

FLOATING SMOKE GRENADE

DATA SHEET

RED SMOKE DATA

Serial No.	Test Date	Percent Composition		Additives	Increment Weight (gm)	First-Fire Weight (gm)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
R-64	5-7-71	54	38	5 Sulfur 3 Ball Pwdr	20/150	2	170	1	180	W	< 2	Good function, volume good - Mix from production batch of approximately 20#.
R-65	5-10-71 A.M.	54	38	5 Sulfur 3 Ball Pwdr	20/150	3	170	1	165	W	2	Production unit - good volume. Ballute - good pressure. Use mix for production.
R-66	5-10-71 P.M.	54	38	5 Sulfur 3 Ball Pwdr	20/150	3	170	1	162	W	2	Good Performance.
R-67	6-9-71	54	38	5 Sulfur 3 Ball Pwdr	20/150	3	170	1	155	W	2	Good Performance.

FLOATING SMOKE GRENADE

D A T A S H E E T

GREEN SMOKE DATA

Serial No.	Test Date	Percent Composition		Additives	Increment Weight (gm)	First-Fire Weight (gm)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
G-56	5-10-71	58	37	2.5 Ball Pwdr	20/165	3	185	1	168	W	2	First test with production mix of approximately 25# @2 minutes - slight chuffing, chuffing increased at 2-1/2 minutes Greater volume is desirable; add more NaPic to production mix.
				2.5 NaHCO ₃								
G-57	5-11-71	See Re-marks	37-1/2	See Remarks	20/165	3	185	1	111	W	2	Added 98 g NaPic to 12,243g of production mix used in G-56. Calculates as 37.5% NaPic. Good volume, good color, smooth flowing, steady flow. Use balance of mix for delivery of production units.
				Production Smoke Mix:			3636g 3636g 4640g 314g 314g					
				Yellow Dye								
				Green Dye								
				NaPic								
				Casting Powder								
				NaHCO ₃								
G-58	6-9-71	←		Same as G-57				1	90.5	W	2	Good performance.

FLOATING SMOKE GRENADE

DATA SHEET

VIOLET SMOKE DATA

Serial No.	Test Date	Percent Composition		Percent Additives	Increment Weight (gm)	First-Fire Weight (gm)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
V-48	5-13-71	57	38	5 Benz-Anthrone	20/150	3	170			W		Used regular flat face ram, pressing smoke, inflation mix and first fire simultaneously.
												On paint shaker 2 minutes - X-ray - No cracks appeared.
												Placed in ammunition box crosswise, allowed to roll back and forth over length of ammunition box for fifteen minutes; x-ray showed no effect.
												Placed in ammunition box lengthwise along with units V-50 and V-52. Units slammed back and forth over length of box for one hour; x-ray - no cracks. Pressed with flat face ram; fuse did not ignite.
V-48	5-13-71	57	38	5B	20/150	3	170		87.5	L		Replace fuze. Very erratic at first, last 60 seconds were good.

FLOATING SMOKE GRENADE DATA SHEET

VIOLET SMOKE DATA (CONT'D.)

Serial No.	Test Date	Percent Composition		Additives	Increment Weight (gm.)	First-Fire Weight (gm.)	Total Composition Weight (gm.)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
V-49	5-13-71	57	38	5B	20/150 (50-50 inflation mix)	3	170		80	W		No shaker test; pressed smoke mix with cone ram 1/2 second. Added 50/50 inflation mix and first fire, 15 second dwell flat ram. Partial ballute at start; volume very strong near the end; bulge at the bottom of the can.
V-50	5-13-71	57	38	5B	20/150 (50-50 inflation m.)	3	170		78	W		Pressed the same way as V-49; same shaker test as V-48; X-rayed - hint of a crack between inflation and smoke mix. Ballute inflation good - volume strong at the end. Can bulged on the bottom.
V-51	5-13-71	57	38	5B	20/150 Inflation Mix: 48.5 Dye 48.5 NaPic 3.0 Casting Powder	3	170		80	W		No shaker test; pressed smoke mix with cone ram etc. same as V-49; inflation mix a. 1 first fire pressed same as V-49. Ballute not full-up at first - volume good - stronger at the end. Can bulged on the bottom.
V-52	5-13-71	57	38	5B	20/150 (Inflation mix same as V-51)	3	170		81	W		Pressed the same as V-49. Same shaker test as V-48. X-rayed - O.K. - appeared best of 49 thru 52.
V-53	5-14-71	58	37	5B	20/150 (50-50 inflation-mix)	3	170		53	W	22	Out at 38; on at 40 seconds; chuffed out at 50 seconds; full 90° cone ram.

DATA SHEET

FLOATING SMOKE GRENADE

VIOLET SMOKE DATA (CONT'D.)

Serial No.	Test Date	Percent Composition		Percent Additives	Increment Weight (gm)	First-Fire Weight (gm)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
V-54	Same as V-53											Canceled test to save the hardware.
V-55	5-14-71	58	37	5B	20/150 (48.5/48.5/3 inflation mix)	3	170		36	W	2	Volume good to 30 seconds; chuffed out at 36 seconds; full 90° cone ram.
V-56	Same as V-55											Canceled test to save the hardware.
V-57	5-14-71	58	37	5B	20/150 (48.5/48.5/3 inflation mix)	3	170		45	W		Chuffed at 25 seconds, weak at 30 seconds; out at 45 seconds. Used flat face ram.
V-58	5-14-71	58	37	5B	20/150 (48.5/48.5/3 inflation mix)	3	170			W		Chuffed at 25, 30 and 36 seconds; out at 40 seconds. Used modified cone ram.
V-59	5-14-71	57	38	5B	20/150 (50/50 inflation mix)	3	170		93.5	W	2	No chuffing, ballute partial for 30 seconds, Ballute out and up just as unit approached water. Volume good, heavier after 60 seconds; used modified cone ram.

DATA SHEET

FLOATING SMOKE GRENADE

VIOLET SMOKE DATA (CONT'D.)

Serial No.	Test Date	Percent Composition		Additives	Increment Weight (gm)	First-Fire Weight (gm)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
V-60	5-17-71	57	38	5B	20/150 (48.5/48.5/3 inflation mix)	3	170		38	W	2	Modified cone ram - out at 38 seconds.
V-61	5-17-71	57	38	5B	20/150 (48.5/48.5/3 inflation mix)	3	170		91	W	2	Volume good, strong after 60 seconds. Modified cone ram.
V-62	5-17-71	57.3	37.7	5B	20/150	3	170		79.5	W	2	Modified cone ram. Volume good, very strong after 60 seconds.
V-63	5-17-71			Same as V-62						W		No data - landed in water upside down.
V-64	5-17-71	57.3	37.7	5B	20/150	3	170		80	W		Used modified cone ram - 48.5/48.5/3 inflation mix - good to 60 seconds, but stronger after 60 seconds.
V-65	5-17-71	57.3	37.7	5B	20/150	3	170		80	W		Used modified cone ram in pressing. Good volume, good inflation, can bottom did not bulge, no chuffing.
V-66	5-18-71	57	38	5B	20/115 (48.5/48.5/3 inflation mix)	3	135	1	104	W	2	Came on strong at 78 seconds. No chuffing, good volume, good inflation. Modified cone ram.
V-67	5-18-71	58	37	5B	80	1st Increment						
		57	38	5B	70	2nd Increment						
	Inflation Mix				20	3	170	1	90.5	W	2	

**FLOATING SMOKE GRENADE
VIOLET SMOKE DATA (CONT'D.)**

D A T A S H E E T

Serial No.	Test Date	Percent Composition		Percent Additives	Increment Weight (gm)	First-Fire Weight (gm)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
V-68	5-18-71 Inflation Mix	58	37	5B	40	1st Increment	170	1	87	W	2	Came on strong at 70 seconds, otherwise, "O.K. except for time. Modified cone ram used.
		57	38	5B	110	2nd Increment						
					20	3						
V-69	5-18-71	59	39	2B	20/150	3	170	1	66	W	2	Used modified cone ram. Pressed height less than normal with this mix - burn time short hard ash; hard ash.
V-70	5-18-71	59	39	2B	20/150	3	170	1	65	W	2	
V-71	5-19-71	57	38	5B	20/115	3	135		80	L	2	Used modified cone ram. Used ballute - holes in chimney were not cleaned. Pressed/mix from oven.
V-72	5-19-71	57	38	5B	20/130	3	150		74	W	2	Used modified cone ram. Clean chimney. Pressed/mix from oven.
V-73	5-20-71	57	38	5B	20/115	3	135		82	W	2	Modified cone ram used. Good performance other than time.
V-74	5-20-71	57	38	5B	20/115	3	135		82	L		Modified cone ram used. No ballute - land test.
V-75	5-20-71 Inflation Mix	59.5	35	5.5B	55	1st Increment	135		63	W		Good inflation & volume, no chuffing; 59.5/35/5.5. Did not burn; burned w/ > velocity at 45 seconds. Modified cone ram used.
		57	38	5B	60	2nd Increment						
					20	3						

DATA SHEET

FLOATING SMOKE GRENADE

VIOLET SMOKE DATA (CONT'D.)

Serial No.	Test Date	Percent Composition		Additives	Increment Weight (gm)	First-Fire Weight (gm)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
V-76	5-20-71	57	38	5B	20/150	3	170		79			Made similar to green by boring 1/2 inch dia. hole in center and filling with foam; good performance but picked up velocity at 45 seconds causing short burn time. Modified cone ram used.
V-77	5-20-71	57	38	5B	20/115	3	135		89	W	-2	Modified cone ram used. Used greater press pressure.
V-78	5-20-71	57	38	5B	20/100	3	120		83	W	2	Modified cone ram used. Regular pressure on ram (4700).
V-79	5-20-71	58	37	5B	55	1st Increment						Modified cone ram used. Good ballute inflations; volume stronger after 45 seconds.
	Inflation Mix	57	38	5B	60	2nd Increment						Color in lower increment not as good as first increment.
					20	3	135	1	89	W	2	
V-80	5-20-71	58	37	5B	65	1st Increment						
	Inflation Mix	57	38	5B	50	2nd Increment						
					20	3	135	1	89	W	2	
V-81	5-21-71	57	38	5B	20/115	3	135	1	90	W	2	Flat face ram. 1/3 more load on ram; good volume, good ballute and no chuffing.

FLOATING SMOKE GRENADE

DATA SHEET

VIOLET SMOKE DATA (CONT'D.)

Serial No.	Test Date	Percent Composition		Additives	Increment Weight (gm)	First-Fire Weight (gm)	Total Composition Weight (gm)	Ballute-Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuse Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
V-82	5-21-71	57	38	5B	20/115	3	135	1	99		2	New mix - no overnite cure; good volume, no chuffing.
V-83	5-21-71	57	38	5B	20/125	3	145	1	93		2	6200 psi pressure. Flat face ram used.
V-84	5-21-71	57	38	5B	20/115	3	135		96	W	2	Modified cone ram used. 4700 psi; chuffing at 30 seconds, O.K. at 40 seconds; volume good.
V-85	5-21-71	57	38	5B	20/150	3	170		82	W	2	Flat face ram used. 4660 psi; out at 27 seconds, back again O.K.; extremely strong velocity at 68 seconds.
V-86	5-21-71	57	38	5B	20/105	3	125		102	W	2	Flat face ram used. 6200 psi, volume good.
V-87	5-21-71	58	37	5B	20/100	3	120		86	W	2	Flat face ram used. 6200 psi, volume good.
V-88	5-21-71	58	37	5B	20/20/80	3	120		86	W	2	Flat face ram used. 6200 psi; volume good.
V-89	5-21-71	58	37	5B	20/100	3	120		87	W	2	Flat face ram used. 6200 psi, volume good.
V-90	5-21-71	58	37	5B	20/100	3	120		90	W	2	Flat face ram used. 6200 psi, volume good.

DATA SHEET

FLOATING SMOKE GRENADE

VIOLET SMOKE DATA (CONT'D.)

Serial No.	Test Date	Percent Composition		Additives	Increment Weight (gm)	First-Fire Weight (gm)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuse Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
V-91	5-21-71	57	38	5B	20/106	3	126	1	101	W	2	Flat face ram used. 6200 psi; vibrated in ammunition box (jolt test approach); steady volume, no chuffing.
V-92	5-21-71	57	38	5B	20/100	3	126	1	103	W	2	Flat face ram used. 6200 psi; steady volume, no chuffing.
V-93	5-21-71	57	38	5B	20/100	3	126	1	99	W	2	Modified cone ram used. 6200 psi; good performance.
V-94	5-21-71	59	38	3B	20/106	3	126	1	15	W	2	Flat face ram used. 6200 psi; good start, out at 15 seconds.
V-95	5-21-71	59	38	3B	20/106	3	126	1	20	W	2	Modified cone ram used. 6200 psi; good start, out at 20 seconds.
V-96	5-24-71	57	38	5B	20/110	3	130	1	99	W	2	Flat face ram used. 6200 psi; good, faster at 90 seconds.
V-97	5-24-71	57	38	5B	20/110	3	130	1	98	W	2	Flat face ram used. 6200 psi; good all the way, no chuffing.
V-98	5-24-71	57	38	5B	20/110	3	130	1	98	W	2	Flat face ram used. 6200 psi; good all the way.

DATA SHEET

FLOATING SIGNAL GRENADE

VIOLET SMOKE DATA (CONT'D.)

Serial No.	Test Date	Percent Composition		Additives	Increment Weight (gm)	First-Fire Weight (gm)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
V-99	5-24-71	57	38	5B	20/110	3	130	1	112	L	2	Flat face ram used. 6200 psi; good all the way, production mix.
V-100	5-24-71	57	38	5B	20/110	3	130	1	106	W	2	Flat face ram used. 6200 psi; production mix, good all the way.
V-101	5-24-71	57	38	5B	20/110	3	130	1	115	W	2	Flat face ram used. 6200 psi; production mix, good all the way.
V-102	6-9-71	57	38	5B	20/110	3	130	1	111	W	2	Flat face ram used. 6200 psi; production mix, good all the way - same as units for shipment.
V-103	6-18-71	57	38	5B	20/110	3	130	1	121	W	2	Good performance - from production run.
63												

FLOATING SMOKE GRENADE

D A T A S H E E T

WHITE SMOKE DATA

Serial No.	Test Date	Percent Composition		Additives	Increment Weight (gm)	First-Fire Weight (gm)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
W-4	4-30-71	62	38	0	20/150	3	170		790	W	.2	Removed sharp corners from RPD material - used button head socket screws. Did not help ballute burn problem.
W-43	5-4-71	62	38	0	20/150	3	170	1	120	W	2	Ballute up good; no chuffing; could use more volume.
	Changed Inflation mix to : 47.5% White Dye 47.5% NaPic 5.0% Casting Powder											
W-44								1	125	W	.2	Same as W-43
W-45								1	140	W	.2	Same as W-43
W-46	Same as W-43							1	140	W	.2	Same as W-43
W-47								1	160	W	.2	Same as W-43
W-48								1	150	W	.2	Same as W-43
10												Conclusion from W-43 thru W-48 - Use Ball Powder in Inflation Mix.

DATA SHEET

FLOATING SMOKE GRENADE

WHITE SMOKE DATA (CONT'D.)

Serial No.	Test Date	Percent Composition		Additives	Increment Weight (gm)	First-Fire Weight (gm)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic									
W-49	5-6-71	62	38	0	20/150	3	170	1	240	W	2	Windy - hard to tell volume output - Ballute little soft first 30 seconds - First Production Mix.
W-50	5-7-71	62	38	0	20/150	3	170	1	255	W	2	Same as W-49
W-51	5-7-71	62	39	0	20/150	3	170	1	131	W	2	*Adjusted a batch from production mix to yield 39.0% NaPic in this test unit.
W-52	5-10-71	62	39	0	20/150	3	170	1	117	W	2	#Modified production mix by adding 182.74 g of NaPic to 11,117g of the 62/38 production mix; calculate NaPic @39%. Inflat'n Mix: 47.5 Dye 47.5 NaPic 5.0 Casting Powder Test - good volume - all O.K.; O.K. to run balance of production units from this formulation.
W-53	6-9-71	62	39	0	20/150	3	170	1	111	W	2	Good Performance

DATA SHEET

FLOATING SMOKE GRENADE

YELLOW SMOKE DATA

Serial No.	Test Date	Percent Composition		Increment Weight (gm)	First-Fire Weight (gm)	Total Composition Weight (gm)	Ballute Inflat. Time (sec)	Total Burn Time (sec)	Land or Water Test	Fuze Delay Time (sec)	Configuration and/or Remarks
		Dye	NaPic								
Y-43	4-30-71	56	39	5 20/150 3 NaHCO ₃	3	170	1		W	2	Removing sharp corners etc. on hardware did not alleviate ballute burn problem.
Y-44 Y-45 Y-46	5-5-71	56	39	5 20/150 3 NaHCO ₃	3	170	1		W	2	*Added 5% Casting Powder to Inflation Mix - takes care of ballute burn holes.
Y-47	5-7-71	56	39	5 20/150 3 NaHCO ₃	3	170	1	240	W	2	Inflation Mix: 47.5% Dye 47.5% NaPic 5.0% Casting Powder Used production mix of over 20#; long burn - relatively lesser volume than on smaller mixes.
Y-48	5-10-71	#	40	# 20/150 3	3	170	1	87 (Too fast)	W	2	#Added 2.7 g NaPic to 160 g from production mix, content of NaPic = approximately 40.01% inflation mix same as Y-47.
Y-49	5-11-71	+	+	+ 20/150 3 39.5% (Calculated)	3	170	1	160	W	2	+Added 117 g NaPic to production mix, 39.6% NaPic; volume 6000, functioned good. Released for production.

FLOATING SMOKE GRENADE

YELLOW SMOKE DATA (CONT'D.)

-78-

APPENDIX J

ENVIRONMENTAL TESTING OF
FLOATING SMOKE GRENADES

TEST REPORT NO. A-3754

DATE 19 May 1971

-80-

REPORT OF TEST ON

ENVIRONMENTAL TESTING
OF
FLOATING SMOKE GRENADES

FOR

NORTHROP CAROLINA, INC.
ASHEVILLE, NORTH CAROLINA 28802

GENERAL TESTING LABORATORIES, INC.

6840 Industrial Road
Springfield, Virginia 22151



	PREPARED	CHECKED	APPROVED
BY	A. A. Ellis	W. P. Dorneloh	C. M. Herring
SIGNED	<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>
DATE	21 May 1971	23 May 1971	23 May 71

DATE 19 May 1971

TABLE OF CONTENTS

	<u>Page</u>
TITLE PAGE	1
TABLE OF CONTENTS	2
REVISION PAGE	3
ADMINISTRATIVE DATA	4
TABULAR SUMMARY SHEET	6
ABSTRACT	7
FACTUAL DATA	8
1.0 Test Apparatus and Equipment	9
2.0 Test Procedure	12
3.0 Test Results	18

REPORT NO. A-3754

PAGE 2 OF 12



DATE 19 May 1971 -82-

REVISION PAGE

<u>Revision Letter</u>	<u>Date</u>	<u>Page Number</u>	<u>Description</u>
Original	19 May 1971		

REPORT-NO. A-3754

PAGE 3 OF 19



DATE 19 May 1971

ADMINISTRATIVE DATA

PURPOSE OF TEST

The purpose of the test program was to assure that the Northrup Carolina, Inc. Floating Smoke Grenades can comply with environmental treatment as described herein and as required by Northrup Carolina, Inc. purchase order number 121250.

TEST PERFORMED FOR

Northrup Carolina, Inc.
Asheville, North Carolina 28802

TEST ARTICLE DESCRIPTION

The Northrup Carolina Floating Smoke Grenade is a cylindrical shaped object approximately 2.0 inches in diameter and approximately 5.0 inches in length.

MANUFACTURER

Northrup Carolina, Inc.
Asheville, North Carolina 28802

APPLICABLE DOCUMENTS

1. Army Regulation AR70-38
2. MII-STD-810B
3. MIL-E-5272C
4. MIP 4-2-804

QUANTITY OF TEST ARTICLES

Group I, fifteen (15) Floating Smoke Grenades, to undergo testing while remaining in the shipping container (wooden crate). Group II, fifteen (15) Floating Smoke Grenades, to undergo testing unpackaged and fully exposed to the required environments. Group III, five (5) Floating Smoke Grenades; Group IV, five (5) Floating Smoke Grenades and Group V, five (5) Floating Smoke Grenades, to undergo testing unpackaged and fully exposed to the required environments. Total number of test articles, forty-five (45).

SECURITY CLASSIFICATION OF TEST ARTICLES

Unclassified

DATE TEST COMPLETED

23 April 1971

REPORT NO. A-3754

PAGE 4 OF 12



DATE 19 May 1971 -84-

TEST CONDUCTED BY

General Testing Laboratories, Inc.
Pyrotechnic Laboratory
Hartwood Division
Hartwood, Virginia 22171

DISPOSITION OF TEST ARTICLES

Upon completion of the test program, the test articles were returned to Northrup Carolina, Inc., Asheville, North Carolina for further evaluation.

REPORT NO. A-3754

PAGE 5 OF 19



TABULAR SUMMARY SHEET

1. Co. Name / Part Name per Generic Code: Floating Smoke Grenades	2. Program or Weapon System: Not Applicable	3. Test Complete 23 April 1971		Yes 1971
4. Originator's Report Title: Environmental Testing of Floating Smoke Grenades	5. Originator's Report No.: A-3754	3. Test Complete 23 April 1971		Yes 1971
6. Test Type, Etc.: Environmental		Report Complete 19 May 1971		1971
7. Test (supplements) report No.:				
8. Test, Size, Rating, etc.	9. Vendor NORTHROP CAROLINA	10. Vendor Part No.:	11. Ind/Gov Std No.:	12. Total Tested: Forty Five (45)
13. Test Results: Etc. Required to Utilize Rept. Evaluation AR 70-38		Enc.	Sent with Report No.	14. MIL Specs./Std referenced: SC C MIL-STD-810B D MIL-E-5272C
15. Test Conditions: ENVIRONMENT		E. Test Levels, Duration and other details		
16. Test Results: Storage & Operations Rain Fall Sea Salt & Sand and D Trans. & A		C. Per Spec	D. Spec. Paragraph / Method / Condition	F. Number Tested G. Number Failed
17. Summary of Report, Nature of Failures and Corrective Actions Taken:				

18. Vendor Informed of Test Result By: <input type="checkbox"/> Letter <input checked="" type="checkbox"/> Copy of Report	19. Signer Aubrey A. Ellis	20. Contractor Northrup Carolina Inc. GTL	Subcontract
18. Vendor Informed of Test Result By: <input type="checkbox"/> Letter <input checked="" type="checkbox"/> Copy of Report	19. Signer Aubrey A. Ellis	20. Contractor Northrup Carolina Inc. GTL	Subcontract

REPORT A-3754
PG 6 OF 19

19 May 1971

DATE 19 May 1971

ABSTRACT

-86-

This report delineates dynamic and environmental testing of forty-five (45) Floating Smoke Grenades for Northrup Carolina, Inc., Asheville, North Carolina.

Storage and Transit Conditions Diurnal Cycle, Operational Conditions Diurnal Cycle, Rain Fall, Sea Salt Fallout, Sand and Dust and Transportation and Aircraft Vibration tests were conducted during the test program.

Upon completion of the test program, all test articles were returned to Northrup Carolina, Inc., Asheville, North Carolina for further evaluation.

REPORT NO. A-3754

PAGE 7 OF 19



DATE 19 May 1971 -87-

FACTUAL DATA

REPORT NO. A-3754

PAGE 8 OF 19



DATE 19 May 1971

-88-

1.0 TEST APPARATUS AND EQUIPMENT

1.1 Storage and Transit Conditions Diurnal Cycle

- 1.1.1 Temperature-Humidity Chamber
Standard Cabinet Company
Model: LHHCA/27FS
- 1.1.2 Recorder/Controller
Honeywell
Model: Y602C43-(AA)-24-III-893
Calibration Due: 18 August 1971
- 1.1.3 Hygrometer
Hygro-dynamics
Model: 15-3000
Calibration Due: 8 October 1971

1.2 Operational Conditions Diurnal Cycle

- 1.2.1 Temperature-Humidity-Solar Radiation Chamber
Tenney
Model A-141D
Thermal Recorder
Calibration Due: 22 May 1971
Humidity Recorder
Calibration Due: 24 May 1971

1.3 Rain Fall

- 1.3.1 Rain Fall Chamber
Industrial Filter and Pump Mfg. Co.
Model: CAR-1

1.4 Sea Salt Fallout

- 1.4.1 Marine Atmosphere Chamber
Industrial Filter and Pump Mfg. Co.
Model: CAR-1

1.5 Sand and Dust

- 1.5.1 Sand and Dust Chamber
General Testing Laboratories
Model: 64FS

REPORT NO. A-3754

PAGE 9 OF 19



DATE 19 May 1971

-89-

1.5.2 Temperature Recorder
Honeywell Brown
Model: 153X64P12-X-42
Range: -150° to 200°F
Calibration Due: 12 August 1971

1.6 Transportation and Aircraft Vibration

1.6.1 Vibration Exciter
M. B. Electronics
Model: C-150

1.6.2 Power Amplifier
M-B Electronics
Model: 4450

1.6.3 Accelerometer (Control)
Endevco Corporation
Model: 2273A
Calibration Due: 5 May 1971

1.6.4 Accelerometer (Monitor)
Endevco Corporation
Model: 2213
Calibration Due: 19 May 1971

1.6.5 Accelerometer Amplifier
Endevco Corporation
Model: 2713A/RA38
Calibration Due: 17 May 1971

1.6.6 Accelerometer Amplifier
Endevco Corporation
Model: 2713A/RA54
Calibration Due: 17 May 1971

1.6.7 Thermal Conditioning Shroud
Wyle Manufacturing Corporation
Model: TE-100-64

1.6.8 Temperature Recorder
Honeywell Brown
Model: 153X64P12-X-42
Range: -150° to 200°F
Calibration Due: 12 August 1971

REPORT NO. A-3754

PAGE 10 OF 19



DATE 19 May 1971

-90-

1.6.9 Control Oscillator
Bruel and Kjaer
Model: N575/N576-1029

1.6.10 Electronic Counter
M-B Electronics
Model: N212
Calibration Due: 12 September 1971

REPORT NO. A-3754

PAGE 11 OF 19



DATE 19 May 1971 -91-2.0 TEST PROCEDURE2.1 General

The forty-five (45) Floating Smoke Grenades were sequentially subjected to the environmental test as presented in Table I.

TABLE I

REQUIREMENT	Group I	Group II	Group III	Group IV	Group V	
Storage and Transit Conditions Diurnal Cycle (per Table 2-3 AR 70-38)	15					
Operational Conditions Diurnal Cycle (per Table 2-3 AR 70-38)		15	5			
Rain Fall NCI Required		15		5		
Sea Salt Fallout (per MIL-STD-810B, Method 509)	15				5	
Sand and Dust (per MIL-E-5272 C ASG, 4.11.3, Proc. III)			15			
Transportation and Aircraft Vibration (MTP 4-2-804)	15					
Functional Testing (total of 45 units)	15	15	5	5	5	

In Group I, the 15 test grenades plus one inert unit will be packaged in both the individual containers and shipping box. This is the configuration in which the grenades would be subjected to vibration, sea salt fallout and diurnal.

2.2 Storage and Transit Conditions Diurnal Cycle

The test articles designated in Table I were subjected to twenty-one (21) hours of Temperature-Humidity exposure as presented in Table II.

REPORT NO. A-3754PAGE 12 OF 19

DATE 19 May 1971 -92-

TABLE II

STORAGE AND TRANSIT CONDITIONS		
LOCAL TIME	INDUCED AIR TEMPERATURE °F	INDUCED RELATIVE HUMIDITY %
0300	94	80
0600	91	84
0900	117	74
1200	150	30
1500	160	10
1800	142	35
2100	105	59
2400	98	75
Max.	160	85
Min.	90	10

2.3 Operational Conditions Diurnal Cycle

The test articles designated in Table I were subjected to twenty-one (21) hours of Temperature-Humidity-Solar Radiation exposure as presented in Table III.

REPORT NO. A-3754

PAGE 13 OF 19



DATE 19 May 1971

-93-

TABLE III

OPERATIONAL CONDITIONS				
LOCAL TIME	AMBIENT AIR TEMPERATURE °F	SOLAR RADIATION BTU/ft ² /hr	AMBIENT HUMIDITY	
			Rel %	Dew Pt. °F
0300	79	0	100	79
0600	78	70	100	78
0900	87	290	82	81
1200	94	360	75	84
1500	95	290	74	85
1800	90	70	82	84
2100	83	0	95	82
2400	80	0	100	80
Max.	95	360	100	85
Min.	78	0	74	78

2.4 Rain Fall

The test articles designated in Table I were subjected to twelve (12) hours exposure to simulated rain fall as presented in Table IV.

TABLE IV

TIME PERIOD	RATE (in/hr.)	TOTAL (in)
1 Minute	27	0.45
5 Minutes	12	1.0
10 Minutes	9	1.5
1 Hour	5.5	5.5
10.73 Hours	0.098	1.05

REPORT NO. A-3754

PAGE 14 OF 19



2.5 Sea Salt Fallout

The test articles designated in Table I were subjected to forty-eight (48) hours of salt fog exposure.

A sodium chloride solution was prepared by desolving five (5) parts by weight of sodium chloride in ninety-five (95) parts by weight of distilled water.

The salt spray chamber reservoir was filled with the sodium chloride solution and the test articles placed on the support racks within the chamber and the chamber temperature adjusted to 95°F.

2.6 Sand and Dust

The test articles designated in Table I were subjected to three (3) hours of Sand and Dust exposure.

The test articles were placed within the sand and dust chamber, the dust density determined, with light source and photo cell smoke meter, to be within the specified limits of 0.1 to 0.25 grams per cubic foot and the air velocity determined, with Alnor velometer, to be within the specified limits of 2500 (+ 500) feet per minute. The chamber temperature was adjusted to 77°F and stabilized for the duration of the test.

2.7 Transportation and Aircraft Vibration

The test articles designated in Table I were subjected to the vibration schedule of Table V for three (3) hours, forty-five (45) minutes at -65°F and three (3) hours, forty-five (45) minutes at 145°F in one (1) major axis only. Prior to the initiation of vibration testing, the test articles were conditioned for a period of four (4) hours at the required temperature.

REPORT NO. A-3754PAGE 15 OF 19

DATE 19 May 1971 -95-

TABLE V

FREQUENCY (Hz)	RESONANCE SURVEY	DURATION
	AMPLITUDE	
5 - 15 15 - 500	0.5 g 1.0 g	30 Minute dwell per resonance
	GROUND VEHICLE	
5.5 - 7 7 - 37	1.0" d.a. 2.5 g's	45 Minutes cycling less dwell
	AIRCRAFT	
37 - 52 52 - 500	0.036" d.a. 5.0 g's	3 Hrs. Cycling less dwell

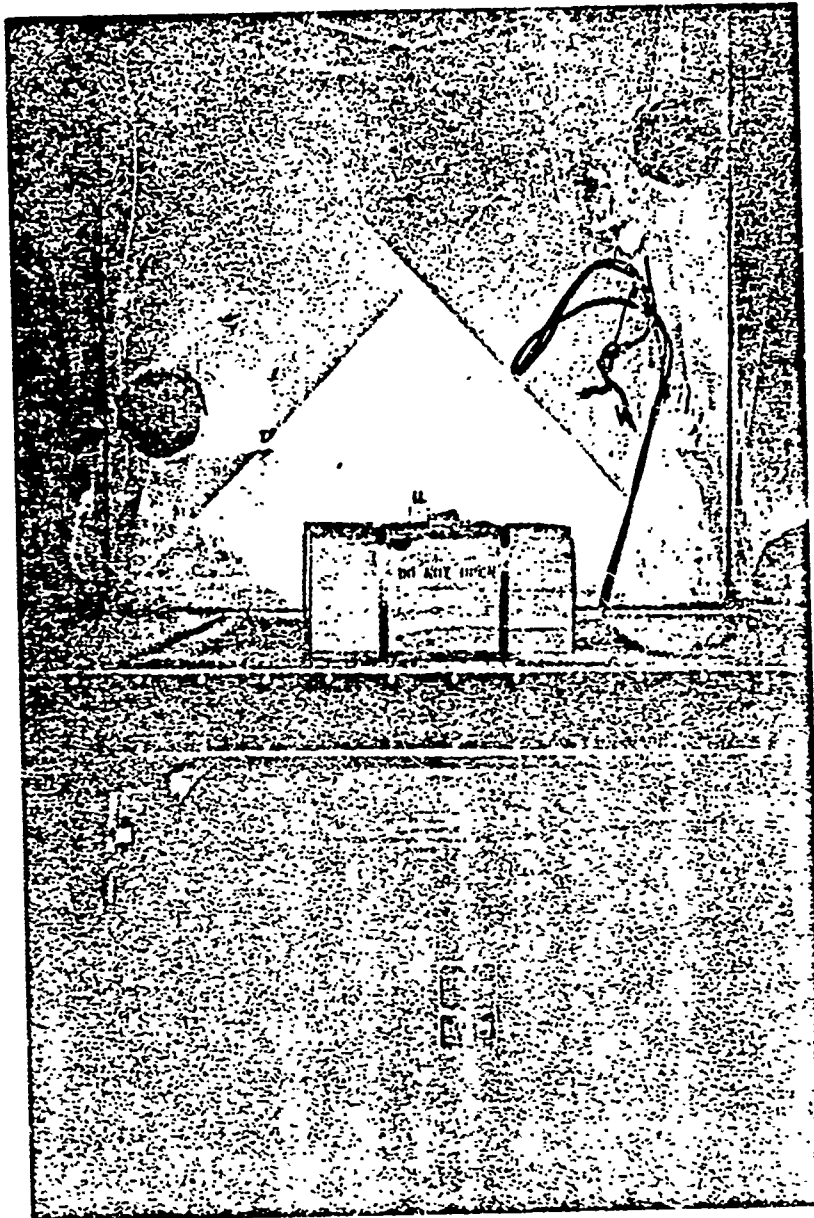
REPORT NO. A-3754

PAGE 16 OF 19



DATE 19 May 1971 -96-

VIBRATION TEST ARRANGEMENT



REPORT NO. A-3754

PAGE 17 OF 19



2.8 Calibration of Instrumentation

All test equipment and/or instrumentation requiring calibration that was utilized in conducting the test program complied with the accuracies and calibration techniques of MIL-C-45662A and was traceable to the National Bureau of Standards. Each instrument displayed a label as to the date of last calibration and the due date of next calibration.

3.0 TEST RESULTS

3.1 Storage and Transit Conditions Diurnal Cycle

The fifteen (15), Group I, Floating Smoke Grenades designated for Storage and Transit Conditions Diurnal Cycle withstood the temperature/humidity exposure detailed in Table II of paragraph 2.2 without apparent indication of damage and/or deterioration as a result of the test.

3.2 Operational Conditions Diurnal Cycle

The twenty (20) Groups II and III, Floating Smoke Grenades designated for Operational Conditions Diurnal Cycle withstood the temperature/humidity/solar radiation exposure detailed in Table III of paragraph 2.3 without apparent indication of damage and/or deterioration as a result of the test.

3.3 Rain Fall

The twenty (20) Groups II and IV, Floating Smoke Grenades designated for Rain Fall withstood the exposure detailed in Table IV of paragraph 2.4 without apparent indication of damage and/or deterioration as a result of the test.

3.4 Sea Salt Fallout

The twenty (20), Groups I and V, Floating Smoke Grenades designated for Sea Salt Fallout withstood the test exposure without apparent indication of damage and/or deterioration as a result of the test.

3.5 Sand and Dust

The fifteen (15), Group II, Floating Smoke grenades designated for Sand and Dust withstood the test exposure without apparent indication of damage and/or deterioration as a result of the test.

REPORT NO. A-3754

PAGE 18 OF 19



DATE 19 May 1971

-98-

3.6 Transportation and Aircraft Vibration

The fifteen (15), Group I, Floating Smoke Grenades designated for Transportation and Aircraft Vibration withstood the vibration exposure detailed in Table V of paragraph 2.7 without apparent indication of damage and/or deterioration as a result of the test at either -65°F or 145°F.

Resonant frequencies determined during the resonance survey is presented in Table VI.

TABLE VI

FREQUENCY (Hz)	RESONANCE SCHEDULE	
	TEMPERATURE (°F)	DURATION
236	145°	30 Minutes
426	145°	30 Minutes
500	145°	30 Minutes
388	-65°	30 Minutes
500	-65°	30 Minutes

REPORT NO. A-3754

PAGE 19 OF 19

